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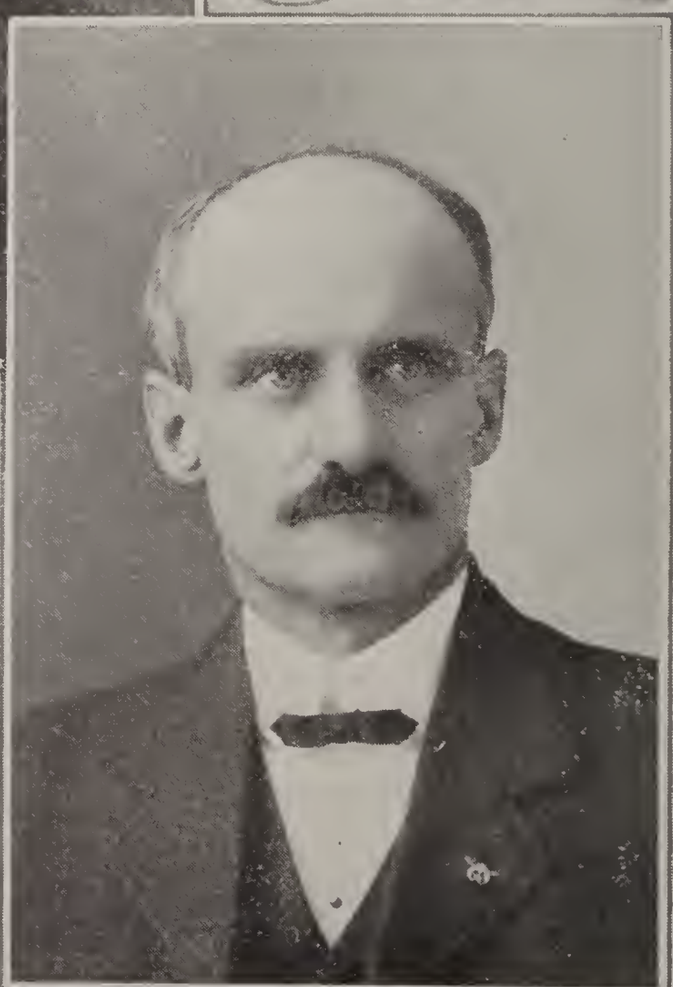

CHARLES A. GENUNG.

*THE*

# ECKELS-GENUNG METHOD

AND

# Practical Embalmer

A

PRACTICAL AND COMPREHENSIVE TREATISE ON EMBALMING,

TOGETHER WITH A COMPLETE DESCRIPTION

OF THE ANATOMY AND CIRCULATION OF THE HUMAN BODY.

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EDITED BY

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# PREFACE.

Embalming, as an art, has made greater progress in the last ten years than in the previous one hundred years.

As the knowledge of the Anatomist, combined with that of the Chemist, has been developed in a practical way in intelligently applying the proper chemicals, preservation of all human tissues has become a possibility.

With the newer and higher grade chemicals and the implements to apply them, the practical embalmer can, with very little trouble, preserve the great majority of bodies with the least possible mutilation, and by experience, treat *all* and *every* condition so that preservation is not only thorough and complete, but the appearance of bodies so embalmed is most pleasing to the friends and relatives, as also is their knowledge of the embalmer's scientific ability to prevent the spread of contagious and infectious diseases, and produce sanitary and hygienic conditions, removing the dread and horror which so frequently is felt in the presence of the dead.

Recognition of the perfection and dignity of the art, gratifying as it is, brings additional responsibilities and necessitates a wider and more scientific knowledge on the part of the embalmer. To be a success to-day, it is absolutely essential for him to be familiar with the structure and anatomy of the human body. It is an irrefutable fact that if the embalmer is thoroughly familiar with the circulation of the blood during life, he is, according to the sequence of incon-

testible logic, familiar with the circulation and distribution of the antiseptic fluid which is injected into the same channels for the purpose of preservation.

In the following pages the Author has endeavored to give, in a plain and practical way, that knowledge of the construction and functions of each part of the human frame which is essential to an intelligent following of the embalming profession.

At first sight, the embalmer may say, "There is too much in this book to learn, too many details shown, and a great many things that do not apply to our business in particular." Do not allow this idea to take possession of you. The time is here when the embalmer is frequently called on to evince a knowledge of even greater detail than is shown herein. The higher the general average of knowledge, the greater dignity and confidence will be reposed in the profession.

HOWARD S. ECKELS.

# PREFACE.

The part I have taken in this work has been done with the desire that those who practice the methods advocated may have the assurance that they have done their work in a practical and at the same time in the most scientific manner. I desire to call attention to what I believe to be the "fundamental principles" of embalming, set down in Rules one and two. It is necessary that the reader understand these rules as thoroughly as he should understand the blood circulation. It is still further necessary that he shall become entirely familiar with the manner of work described in these rules, as reference will be made to them throughout the entire work. I trust that all may be benefited by so doing as much as this line of procedure has benefited the author.

CHARLES A. GENUNG.

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# PART FIRST.

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*By Howard S. Eckels.*

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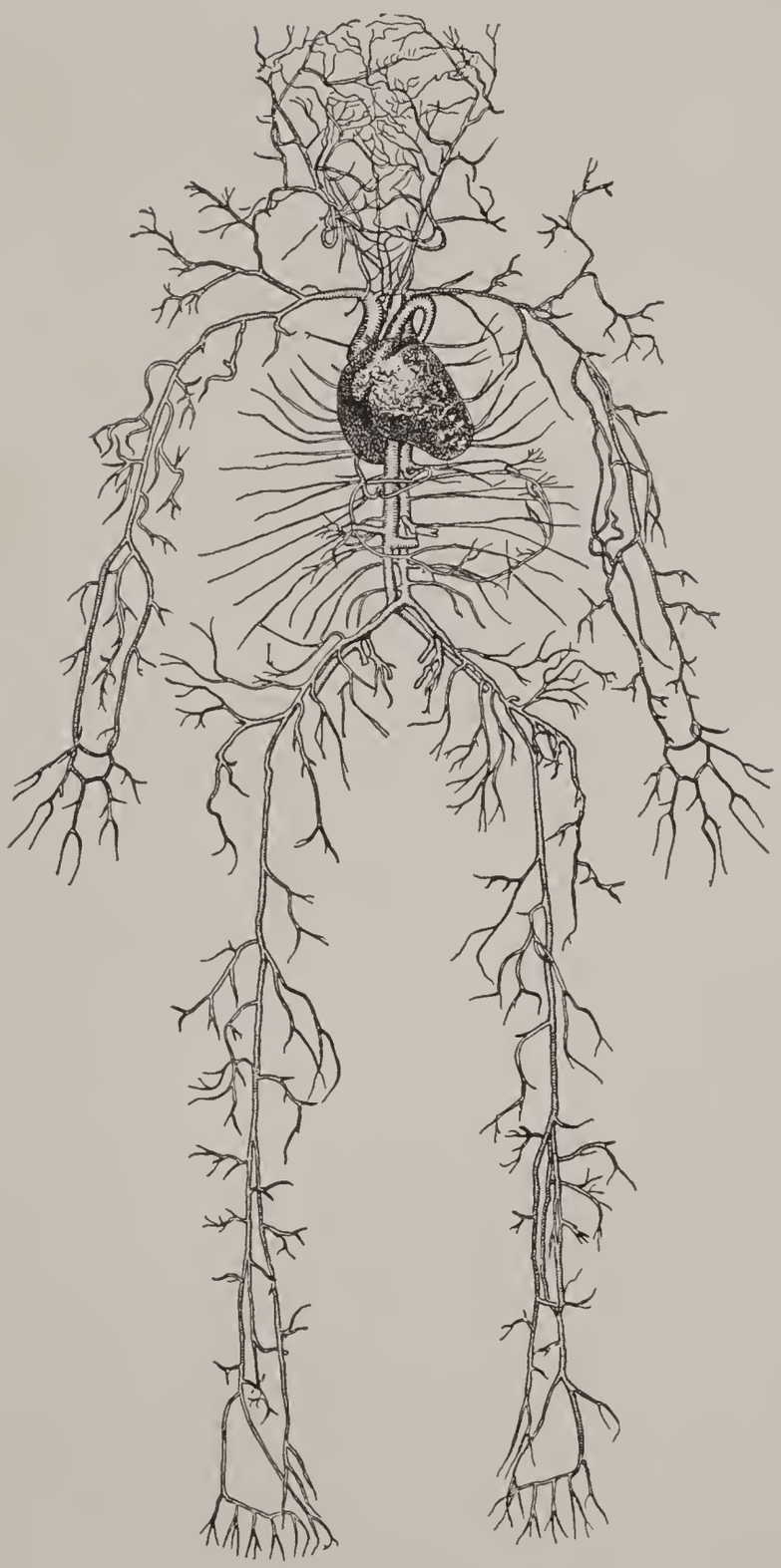



The human heart and great blood vessels with the entire arterial system. Dissected and diagrammatically mounted in its full size by H. S. Eckels. The only specimen in the United States. Just finished. The first exhibit.

# PART FIRST.

## Instructions and Methods of Embalming.

*By Howard S. Eckels.*

In contrast with the usual treatise on this subject, we begin at once a condensed or advanced Post Graduate course of instruction for the Undertaker already engaged in the business, and the Embalmer who has had a preliminary training and practical experience in embalming. It is, in reality, prepared for the up-to-date man—the busy man—on the lines of specific treatment for the difficult, unusual, and peculiar cases met with in everyday practice; and while a "head full of good common sense" is the most essential feature, in conjunction with this, a realization that the circulation of the blood during life, through its arteries, conveys the blood to the tissues, guides the Embalmer in his distribution of the fluid through each and every artery, to reach all parts of the body.

The arteries of the systemic circulation (that which the Embalmer universally uses) begin *at the left ventricle* of the heart, at the semilunar valve. This valve, which controls the blood circulation in life, also controls the circulation of fluid in embalming, forming, as it were, a water back that holds the fluid in the arteries, and, when they become full, forces it on through the capillaries to the lymphatics, and surely into the veins if the process of injection is continued without obstruction. As circulation existed in life, it is well to bear in mind the logical conclusion that wherever this

circulation has been in evidence, there the circulation of the fluid may be readily and easily obtained with proper application and care. It is never a good argument, particularly to yourself, that "circulation is not to be obtained," for the fact is that the channels do exist, and circulation may be had always, though not always in the same way.

The object of embalming the dead is obvious. It is the only means of keeping a body for an indefinite time, and of knowing that it will retain its life-likeness. It further prevents all obnoxious odors and gases from arising, rendering the atmosphere wholesome, and the body beautiful in the eyes of the relatives and friends, and as the embalming fluid contains antiseptic properties, a great health preserving service is at the same time rendered to the public.

Embalming seems to the ordinary mind a mysterious application of a difficult science. A thoroughly skilled Embalmer, with his intimate knowledge of the human body, properly steps into a higher position than an ordinary Undertaker. You enter the house of the dead like a physician, with your cabinet of instruments, and proceed to do your beneficent work and to maintain your position and the dignity of your profession. It is essential that you should treat a body with intelligence and care, and assume a responsibility which requires your further attention, being ready to take care of the conditions as they arise, the successful treatment of which marks your success.

We wish to call your attention to the Anatomical Aid and Manikin Chart. The Anatomical Aid is a valuable appliance, as a reference to the Manikin Chart, which shows all of the trunk arteries, veins, organs, and the entire anatomy of the body, which guides the student and enables him at all times to see exactly what he is doing.

Lying directly over the muscles in the body section of the Anatomical Aid, the skin plate affords many advantages, as it enables you to see their true relation to the skin surface, which is quite important when introducing the needle or trochar. The organs as represented in the Anatomical Aid correspond with the size of this body; so, to find any particular spot on the body on which you are operating, simply take the length and breadth of the trunk (or body) and allow for the difference in size. You can thus locate exactly the organ or spot required, and avoid penetrating arteries.

Never work too hurriedly, and always watch the object, for in some cases damage may occur by rupturing an artery. However, this happens rarely, as the arteries are very tough and elastic, yet it is advisable never to inject fluid too rapidly. A gradual and steady flow is best obtained by gravitation, and when embalming fluid is injected in this manner, no difficulty will be experienced.

About one to two hours should be devoted to embalming a body, the time given depending upon its condition, size, weight, how long dead, and the length of time to elapse before interment.

## SUGGESTIONS AND CAUTIONS IN SELECTION OF ARTERIES FOR INJECTION.

### COMMON CAROTID ARTERY.

To professional embalmers one of the most important arteries is the Common Carotid (1, Blood Formation). Its advantages are that it is large enough to admit almost any size tube; it is very easily located and raised; it carries the fluid injected into it, and passes directly into the large arteries and distributes freely throughout the entire arterial system; it has the great advantage of the most direct circulation to the face, especially when you are injecting

towards the head. The majority of embalmers prefer to inject the Carotid artery downward first, because the opposite side of the face receives its quota of fluid through the Carotid artery on that side, and the complete and satisfactory evidences of perfect circulation there indicate to the observing embalmer when sufficient fluid has been injected. At this point the injection of the fluid is close to the center, or beginning of the circulation, the heart, and the more direct the circulation the greater the certainty of success. But the very greatest advantage is from injecting by direct circulation the exact quantity of fluid desired in the face tissue, this being the exposed part of the body. It matters little what kind of case is to be injected, this free, thorough circulation proves the greatest satisfaction in embalming.

In coloration produced by the presence of blood, the washing of this blood from the capillaries and tissue is most certain by the direct injection through the arteries, washing it from the capillaries into the veins. It is a mistake to fear that a reasonable amount of fluid injected in this way will over-embalm a body. The appearance of over-embalming most frequently occurs from the *contact of blood in the tissue with the fluid,* which, remaining there, causes not only the discoloring of the walls of the capillaries and the substance of the tissue, but also toughening and drying of the tissue by the fluid, whereas, had the fluid circulated freely, washing thoroughly and altogether clear from the tissue the blood which caused the coloration, then the firm, dry, clear, waxy appearance of the flesh tissue would be natural and altogether desirable.

In many cases, after injection downwards through the Carotid artery, an injection upwards through the other end of the artery (in the same incision) insures success. In

cases like Consumption, Typhoid Fever, Aneurisms, Ruptures, Lesions of any kind which would be subject to a leakage from the general circulation, both Carotid arteries should be injected upwards, as the injection of the Brachial or Femoral arteries, would fail, on account of leakages in general circulation, to drive the fluid satisfactorily from the arteries of the trunk of the body up to the face.

### THE AXILLARY ARTERY.

To the progressive, "up to the minute" embalmer, the axillary artery offers the greatest advantages in embalming bodies for the present day funeral, where the appearance of the embalmed body indicates the character and considerate qualifications of the able funeral director and the painstaking skill of the embalmer. All logical reasonings offered on embalming have been based upon the blood circulation previous to death. This being true, it is at once apparent to all, that when the embalmer delivers the injected fluid at once to the beginning of the systemic circulation, the ascending Aorta, by the Axillary arterial tube from whence the embalming fluid radiates towards every extremity in the exact proportion which was natural to the circulation during life; thus the four trunk arteries leading to the head will convey the proper quota of fluid for its perfect preservation and produce the most natural appearance. With this method of injection, the body need no longer be laid flat for the purpose of "even distribution", sacrificing one of Nature's laws in gravitating the blood from the face and neck. Instead, the body is placed in an easy, comfortable appearing incline, to allow the blood to drain from the neck and face. This will aid the free circulation of the embalming fluid, which is radiated through the arteries of the upper trunk and which fluid being delivered clear and without blood con-

tamination to the very origin of the branches of the arch of the Aorta, the carotids of the head, and the subclavian to the hands; thus all of these exposed parts of the body are cared for in the most scientific and common-sense way yet devised in embalming.

The Axillary artery is now used almost entirely by some embalmers when injecting bodies. Many claims may be made in favor of its use, and some important ones are: It is always very superficial, always of large diameter; within it fluid is passed only a short distance before it is emptied directly into the aorta, this being very desirable in all cases.

The axillary vein can be raised from this same incision, being the best and most convenient vein of the body from which blood may be drawn. Surely no reasonable objections can be advanced to an embalmer making this one incision in the axilla, as there is no objectionable exposure and the least noticeable mutilation; while the results that may be obtained are always desirable, and thoroughly scientific.

In cases where the systemic circulation is intact, all may be accomplished by using this artery, that may be by using any other.

The axillary artery and axillary vein can be raised easier than any equally large ones, for even on very stout bodies they are quite superficial and always easily reached, and may be operated on in a neat manner in all cases, provided the embalmer uses the improved, up-to-date, axillary artery and axillary vein tubes.

### BRACHIAL ARTERY.

Not the least important artery for embalming purposes is the Brachial artery, situated in the arm. Being of good size, it is capable of receiving a large-sized tube in its canal.

This artery is used in many cases of embalming with the best success, its location admitting of its use at any time in female as well as in male subjects.

It is easy to find on account of its landmarks, the borders of the biceps and triceps muscles; it is more superficial than any of the others that are used, excepting the Radial and Axillary arteries, and it receives the fluid easily and readily.

The arm being directed outward in a horizontal direction gives the course of the brachial almost straight to the arch of the aorta, through the Axillary and Subclavian arteries, the Vertebral and Common Carotid receiving the fluid on its course, and carrying it to the face, head and brain, passing around the circle of Willis, and supplying the numerous branches which are given off in their locations, thus embalming the upper and lower extremities at one and the same time. Thus it is evident that embalming through the Brachial artery often has great advantages.

The superior and inferior profunda of the Brachial frequently carries fluid to the arm and hand, but while it is a fact that in a majority of people these arteries connect or anastomose with the Radial and Ulnar arteries and carry blood freely through these during life, yet in morbid anatomy in its passive condition the circulation does not by the recurrent force convey fluid sufficient and with pressure enough to drive the same to the extremities of the smallest arteries, the capillaries, and as a result you often find "skin slip" and signs of decomposition. This occurs particularly in the summer time, and on the arm and hand of dropsical cases, where the Brachial has been used only towards the trunk in embalming; therefore, on such cases it is advisable, after injecting towards the trunk of the body all of the fluid which is needed there, to reverse the tube in the Brachial artery, injecting a few bulbfuls towards the hand, sufficient to pre-

serve the tissue there. This is also of the greatest benefit in removing discoloration from the hands and fingers under the nails, when same occurs from congested blood. While injecting this way great benefit follows from manipulation there with the hands or with a soft sponge made moist. This stimulates the circulation of the fluid to the surface lymphatics and tissue, so that even on the worst dropsical cases no blisters or slipping of skin will ever occur.

## HOW TO LOCATE, RAISE AND INJECT ARTERIES.

### AXILLARY ARTERY.

The axillary artery is most desirable for many reasons. It is superficial, being closer to the surface than any other equally large artery. It is well hidden by the position of the arm, which is folded over the body and thus is protected from the view of any specially curious member of the family. It exists in the arm pit, the incision for the Axillary being made in the hair line, which is still more obscure than when the artery is selected farther down the arm. Its course is marked by the continued depression which exists between the biceps and triceps muscles.

The axillary artery is found immediately beneath the median nerve. On account of the size of the artery, it is more easily found and distinguished better from the axillary vein, than is the brachial artery from the basilic vein.

To raise the artery, place the arm at right angles with the body. The incision should be made carefully and not too deep, as this artery is found close to the surface. Start the incision close to the trunk of the body, extending the cut downward over the course of the artery, through the skin and fascia. Very little fat tissue exists here, even in the stoutest people, hence this is always an easy artery to raise. Make the incision about an inch and a half to two inches in length. Frequently the vein makes its appearance first. The

INCISION FOR THE CAROTID ARTERY (either one, or both.)

blood in the vein shows dark, and by pressing upon the tissue on the hand side of the incision, you will readily force the blood towards the trunk of the body, expanding the vein, so that it is easy of recognition. The artery is found nearer the front or upper portion of the arm and beneath the nerve, and in a sheath associated with one or two small veins, the nerve and tendon. Separate these and select the axillary artery. You will be able to determine between the artery and the nerve by pressing on the arm over the artery towards the incision, thus collecting the blood in the artery, which will fill, and so indicate it from the nerve. This is more easily noticed when a slender instrument (aneurism hook) is used instead of the finger in raising up the artery and nerve, because too much pressure beneath the artery will prevent the distension and circulation of blood through it which has thus collected. In all normal conditions, an easy comparison is made between the artery and the vein. The artery should have two ligatures placed around it, one towards the hand being tied to prevent leakage. The artery should then lay flat on the bone separator, the artery being tapped by the use of the scalpel, and the axillary artery tube, which should be long enough to pass into the artery all of the way to the arch of the aorta. When this has been accomplished, the ligature should be tied around the arterial tube, which, if of the proper sort, will permit of the single knot to hold it and to prevent leakage. Thus when the tube is removed this knot is easily drawn tight. This is quite a convenience to the operator. The tube should be reversed in the artery, or else a two-way tube should have been used, so that with turning the valves, an injection of a half pint ot fluid may be made in the arm towards the hand, thus properly embalming it and clearing all discoloration from the finger tips and from beneath the finger nails.

The selection of this artery at this point and with the axillary arterial tube conveying fluid directly into the aorta, does not cause the rigid condition of the arm which usually occurs when injecting fluid into the brachial artery. Hence, when you have finished the arterial injection, the arm and hand may be placed over the body with ease and in the position which is desired at the time of the funeral.

Fluid should be injected into the axillary artery and continued until the usual positive signs of thorough circulation and disinfection of the body have been obtained. (See rules page 88.)

The greatest advantage of the axillary artery in the injection of fluid is that you deliver your fresh (uncontaminated with blood) fluid directly into the arch of the aorta, where the common carotid arteries branch from it, thus delivering this clear fluid into the face, forcing all of the blood therefrom through the capillaries into the veins, which, draining from the head and neck through the several jugular veins, all empty both directly and indirectly into the innominate veins. Indeed, all of the veins of the upper trunk of the body drain directly to this point, and is reached through the axillary vein, which accompanies the axillary artery, and with the arm in the position as described for raising and injecting the axillary artery, the newest and most approved vein tubes may be used in this axillary vein to drain the blood from the innominate veins, thus providing perfect circulation of fluid through the tissue while draining the blood constantly and thoroughly from the body.

### RIGHT COMMON CAROTID ARTERY.

(1, Blood Formation, and 19, Head Plate.)

First as to its location. It is a branch of the arteria innominata (2, Blood Formation), and arises from behind the

right sterno-clavicular articulation, and proceeds in a direct line to the upper border of the thyroid cartilage, about opposite the angle of the jaw bone, where it divides into the external and internal carotids. The direct course, then, of the Right Common Carotid artery is from the sternal end of the clavicle (5, Rib Plate) to the mastoid process, a point indicated by the lower lobe of the ear.

To raise this artery for embalming purposes, mark out a line as indicated, and choose for the point of incision its lowest part, as near the clavicle (collar bone) as possible.

Make an incision directly on a line across the center of the body at the upper end of the sternum bone, between the angle or articulation of the right and left clavicle. This will enable you to take up either the right or left Carotid artery, and it may be desirable to use both of them for the injection of the head, in the event that the body is posted, or that an aneurism or leakage is discovered, or when injecting downwards a flushed condition of the face occurs and the blood may not be readily drained away, or in cases where congestion of the blood has occurred one or more days previous. Direct circulation always has advantage over general circulation, inasmuch as all of the fluid injected is conveyed to this extremity, instead of only a small proportion; this incision admits of raising either or both of these arteries, which frequently is most desirable.

The Lineal Guides there are the group of muscles which we term the Mastoid muscles—these on the outside, and the trachea, or windpipe, on the inside,—direct your forefinger, which is used to separate the superficial as well as deep-seated fascia, and directing the finger towards the head, instead of towards the body, soon guides it immediately on top of the Carotid artery.

Some care should be observed not to rupture the jugular

vein, which lies immediately beneath those muscles, and with such care the Carotid artery may be brought to the surface through an incision not longer than 1 or 1½ inches at the most, without causing any rupture of the veins, which would give immediate annoyance.

Special attention should be given in your first efforts in raising the Carotid artery to realize that while with your forefinger you have separated the deep fascia surrounding it on the top, and perhaps on the sides, you have not done this on the lower side, and that your aneurism needle, which is of great assistance to you in raising this artery, pushes through this fascia on the lower side; but this only admits of your drawing the artery up by pressing away the tissue with your forefinger, while with the hook in the other hand you separate and push away this fascia, gradually allowing the artery, which is on your hook, to come through to the surface, and so continue until you can pass your finger and instrument beneath the artery, when with your blunt-end aneurism needle you can separate the tissue off the outside of the artery until it comes out clear and clean and the artery alone is separated from all of the adhering tissue. As the artery is flexible, particularly so at this region, you will find it will come to the surface freely and easily, and be accessible for injection in both directions.

Raising the artery at this point, pass two pieces of silk or string under it, one piece at the lower, the other at the upper end, as it lies in position for making your incision, with bone or rubber separators placed under it.

Make an incision into the artery about its middle, sufficient in size for the insertion of your tube or nozzle. This puncture or incision is to be made for this one purpose, *i. e.*, the introduction of the nozzle in question, and should be made with special reference to its size. The easiest, quick-

est, and surest way of making this incision is to raise the artery over a separator or a piece of wood, and enter the point of your sharp scalpel on the edge of the artery far enough to make the incision to get the opening necessary. In this way you cut the three coats clear and clean, and have no difficulty in getting into the canal, nor danger of severing your artery in twain, an accident which would make bad work, as the elasticity of the artery carries the severed ends out of sight at once, and you are forced to seek them with much painstaking—the one part far up in the neck, and the other part in an opposite direction. .

Too much care cannot be used in this simple little operation of the incision. Be sure the incision penetrates the canal of the artery, as it happens occasionally by the longitudinal cutting that the cut only reaches through the first or second coat or tunic. In such a case there is trouble again, for the operator is no better off with only the first and second coat penetrated than as if no incision had been made.

Another test which I invariably use is to first introduce the director, or fascia needle, a little instrument which is half curved, has a crevice, and also a flat end, which enters the artery very easily and shows definitely whether the incision is made of sufficient size. This instrument is used as a protection against the blunt end of the embalming tube, and should always accompany it, placed with the crevice down so as to direct the artery tube. It is about six inches in length. Place the director in the canal down towards the body, and allow it to enter as far as possible. Usually, on withdrawing it, a few drops of blood will follow, thus affording a sure, easy test.

After you are positive you have made a true incision, introduce your director into the artery, lifting it towards you a little, thus opening the incision to admit of an arterial nozzle.

In this way you will not push down one of the inner coats of the artery, which is occasionally done, particularly in Bright's Disease cases.

After entering arterial tube directed towards the body, introduce one directed towards the face. Ligate both tubes securely.

When the tubes are properly in the canals, securely fastened, and all in readiness, proceed to inject fluid with ordinary dispatch.

While your fluid is flowing towards the body, and going into the general circulation, which is divided through so many of the branches from the aorta, the only caution the operator need observe is that the fluid is being circulated evenly all over the body. This may be aided materially by manipulation, either with the hands or with a wet sponge. Rubbing well will quickly develop capillary circulation which will surprise the novice, showing great benefit to be derived from it, and while this does not attract the attention of the operator to any great extent on the majority of cases, it is highly important that we undersand its possibilities, because on bad cases this manipulation may be used with great success, particularly with blood congestion or coloration of face, hands, or arms.

Continue the injection until you think sufficient fluid has been used. The rule, on ordinary cases, is to use a quart of fluid to every 50 lbs. Thus on a body of 200 lbs. a gallon of fluid would be used arterially. Observe closely the superficial veins, such as the temporal and facial veins. Should they raise or bulge under the strain, this is positive proof that the entire venous system is distended, and that blood should be drained therefrom.

After a few minutes, perhaps five, continue the injection until you have used the needed amount. Three quarts will

THE RIGHT CAROTID ARTERY.

be ample in the average case of 150 lbs. I have injected, and have seen others inject, a much larger quantity; but ordinarily, where only a few days' preservation is desired, the above amount will be sufficient. Still, the operator's judgment must be the arbiter throughout.

When the injection is complete, remove the nozzle and tie up the end leading towards the body. Loosen the other ligature (which should have been made with only a single knot, tied with a fairly good sized cord, so that it would not cut through the inner wall).

The director may again be used, and the arterial nozzle entered towards the face. Here great care is necessary to obtain the best results. Just enough fluid should be injected —from 3 ounces to a pint may be used—but from the very beginning the closest observation should be made, as swelling of the eyes or face can very easily and quickly result from this direct injection. This, of course, would change the countenance and expression. It is easy to see this, however, if the operator is watching, and the first intimation of it is conclusive proof that sufficient fluid has been injected therein.

If this produces a nicer, or whiter and more waxy appearance than exists on the opposite side of the face, it is best that the operator, through the same incision made to raise this artery, should raise the Carotid artery on the other side and inject it with a like amount of fluid, to obtain like results.

As formerly stated in cases of flushing, this is positively sure of removing it, particularly if the blood is relieved from the Vena Cava, thus draining all the veins which run into it. This is quickest done by entering a small cardiac needle between the second and third rib on the right side of the sternum bone, staying also on the right side of the back bone,

along the groove of which the superior Vena Cava lies. Rupturing this will relieve the blood, as the Carotid arteries are mostly used for the direct injection of fluid into the head in posted cases, and those where the general or systemic circulation is ruptured. The Vena Cava can be punctured and blood drained in all such cases where the vein tube would not relieve the blood, nor prevent its forming in the cavity at the place of rupture. In all cases where the venous circulation is not ruptured, a safer and more scientific method is to remove the excess of blood by means of a draining tube inserted in the Jugular or Axillary vein.

When aspirating the blood, do not produce too much suction, as excessive suction would draw the tissue, or substance of the lungs into the perforations of the trocar, stopping them up. To keep it open, it may be pressed gently up or down or side to side, thus changing its location in the cavity ½ inch or more, allowing the blood to accumulate in the cavity thus made around the needle, which will admit of its being easily drained out by aspirating into the bottle. It may be desirable to use this method of drawing the blood while injecting any of the arteries, and in cases where there is an excess of blood this operation may be started any time after one-half or two-thirds quantity of the fluid is injected into the artery.

It is well to always establish circulation before starting to draw the blood in this way, because, unlike the vein, it is impossible to tie up the puncture in the Vena Cava or right auricle of the heart caused by this rupture. This is of little consequence, however, after the circulaton is established, and thereafter will only drain into the cavities surrounding, and not cause any annoyance through leakage from the surface of the incision, or if it does, it may be easily stopped by plugging a little cotton or sewing the incision.

I might add just one more word of advice to the operator who is so unfortunate as to rupture a vein while raising this artery for injection. In that event, there is a constant leaking of blood, which grows worse as the fluid is injected into the arteries. Sometimes this may be prevented by using a self-closing forceps, or vein clamp, but if it occurs deep in the incision, and is unhandy to get at, tap the superior Vena Cava, or right auricle of the heart, drain the veins to the point of the rupture of the needle, so there is not the quantity of leakage at the point of the incision at the artery. This is worthy of your special note, particularly in the event that you are operating before critics. A rupture of this kind occurring would prevent you otherwise from doing a clean and neat operation.

After the injection and the removal of the nozzles, wash out the wound with a soft moist sponge. Pack absorbent cotton in snugly, sew up the wound with close stitches over and under (as a baseball cover is sewed), and draw each stitch tight. Silk should be used for this purpose.

### HOW TO LOCATE, RAISE AND INJECT THE BRACHIAL ARTERY.

The Brachial artery is used perhaps more than any other artery in the body for the present day embalming, and with the Axillary artery it perhaps is entitled to this popularity, particularly with those operators who prefer to use one of the various kinds of vein tubes for removing blood from the venous system.

In large, well developed, and old people, it matters little whether the Brachial or Axillary is used, each being large enough; also the accompanying vein (basilic) is large enough to receive at least a medium-sized vein tube, but in young and less developed people it is advisable to raise the artery high in the arm, indeed at the bend of the shoulder, where the Axillary is found, because there both the artery and vein are con-

siderably larger than in the middle third of the arm, where the Brachial is usually raised.

The Brachial artery (B, plate 4, Upper Extremity) is the continuation of the Axillary artery, and commences at the entrance into the arm from the axilla, or arm-pit. It continues, in a more or less spiral course, to the bend of the elbow, where it gives off two branches, which are called the Radial and Ulnar arteries. If the arm is directed outward in a straight line from the body, with the palmar surface of the hand towards the feet, the artery pursues an almost straight course. For this reason it is advisable to extend the arm outward before making an incision, then you can make the incision in a straight course, and with exactness.

The artery lies near the Humerus (the bone of the arm), and between the two great muscles, the biceps and triceps, on the inner side of the arm, the biceps being on the upper side, forming, as it were, an overshoot, and the triceps on the lower side of the artery. It lies along their edges or interior borders, closer to the biceps, and is hidden from view until the muscles are separated. That work is accomplished easily by the use of the bone separator and aneurism hook.

Make the incision about two or three inches below the arm-pit and in the middle of the arm between the muscles. Make it from one to two inches in length. Cut through the skin and fascia on a straight line with the bone of the arm. Then separate very carefully the fat and muscles, and hold the muscles apart, thus exposing to view the sheath containing the nerve, the Brachial artery, the two Vena Comites, cords, etc.

You are seeking the artery, and may depend upon finding it always in the same place. In surgical anatomy the description is different, because a slip of the knife might sever the artery and cause death, therefore the greatest caution is

always advised, but in our work, where no danger results from such anomaly, we may better direct our efforts according to the lineal guides which we have for the artery.

The Brachial artery is contained in the same sheath which surrounds the median nerve and the two accompanying veins (venæ comites, or Brachial veins). These lay closer to the biceps muscles, which in many arms form a little "forbay" over them. Push this back with the thumb towards the top of the arm. This will expose to view, and to the sense of touch, the nerve and artery, which lie immediately beneath. Separate this from the other substances, pushing the tissue away from it, and pass the finger of the left hand beneath; then, with the freedom of the right hand, the blunt aneurism needle may be used to the best advantage in separating the nerves, arteries and veins.

To the practical man this is all accomplished in less time than it requires to tell it. In certain abnormal conditions the arteries vary, and instead of one artery there may be a bifurcation of the Brachial artery into two arteries. Statistics show that this occurs about once in every 12 cases. I might add, however, that it occurs more frequently in the left arm than in the right, and the majority of cases are females.

When these arteries are divided in two (occasionally in three) they are proportionately small, and where such abnormal condition exists it frequently occurs that the vein is somewhat changed. Even the walls of the veins are thicker, therefore less distinguishing features exist in contrast with each other, and in consequence the usual signs of determining the artery are absent. The sense of touch does not distinguish the artery. The walls of the veins, being thick, do not show the color of the blood so plainly through them by their transparency, so by the sense of sight we can not so well distinguish the artery from the vein.

Branches of the artery so varying do not point out by their construction the difference between the artery and the vein, and perhaps it remains for us to use the only certain and specific test for the artery, which is the injection of this same artery towards its extremity. This at once develops capillary circulation, which is a sure sign that it is the artery. The veins in the arms have valves which always prevent this capillary circulation, usually the fluid will not flow through the vein towards the hand—perhaps not more than once out of a dozen times—and even when it does it only goes to where there is a branch from that vein to another one which leads it back towards the body.

Please make no mistake about this test; it is absolute and specific. Injection through the vein towards the extremity does not admit of circulation there, but circulation towards the body is no test, because it is natural for the blood to flow through the veins towards the trunk; therefore as much fluid may be injected in the vein as in the artery in this way, and of course it would be of no benefit, but probably detrimental to the appearance of the body, on account of the flushing of the blood from the veins through some valves, particularly in the neck, which would admit the blood and fluid passing through them.

After determining which is the artery, by whatever means you find necessary, its separation from the vein, as a rule, is easily accomplished.

The artery should be raised to the surface, and two strings passed under it. Then raise the vein, and proceed in the same way as for the artery. You can open this vein in the arm, using the vein tube, to relieve the discolorations in the face, if necessary. This acts very nicely, particularly where there is an excess of blood.

The vein tube can easily be passed into the vein, especially

BOTH CAROTID ARTERIES (one incision 1½ inches long.)

if a cross incision is made half way in the vein, then a little cut from that point upwards about ¼ inch long. Holding the little flaps open with tweezers enables the operator to pass the vein tube therein as far as it is necessary to go.

It is usually supposed that the vein tube should enter as far as the right auricle of the heart. There is no objection to this, but there is surely no need of it, as the last valve in the subclavian vein is at least one inch from where it empties into the innominate vein, and therefore does not prevent the free flow of blood from the other veins to it (see plate)—jugulars on both sides of the neck, and all their branches through the innominates or Vena Cava, to the subclavian on the other side, so that draining the blood at that point, or anywhere in this tract, relieves the veins which drain the blood from all of the exposed parts of the body, head, and hands, hence admits of a free circulation of the fluid through this tissue, washing out the capillaries in a most thorough and practical manner, and therefore prevents flushing, and with a little careful manipulation of the tissue of the face and hands while the injection of fluid is taking place, distributes it evenly through the face as well as the hands and arms, and leaves the clear fluid in the tissue, which produces the nicest and clearest complexion, which is so desirable to the embalmer.

As the flexible vein tube is larger than the arterial tube, and more cumbersome to handle, it is best to enter it in the vein first. After getting it properly placed therein and tied, a nipple or cut-off on the vein tube will prevent any annoyance by escaping blood and leave the operator free to enter the arterial tube. The work will thus be better done.

After bringing the artery to the surface, and when the strings are placed, tap it by inserting the point of your scalpel into it, the artery being stretched across the handle of an

instrument. Then insert the nozzle into the opening you have made, pointing it toward the body, then make the nozzle fast by ligatures already prepared, and inject the embalming fluid.

After injecting a quart or more of fluid, you will find, by taking the nipple off the vein tube and attaching a rubber tube thereto (allowing this to drain into a bottle), that in almost every case a free flow of blood will occur. Allow this to continue while you are injecting fluid, and then so long as it runs mostly blood; afterwards withdraw the vein tube and tie up this end of vein, the other end, of course, having been tied up at the time you entered the vein tube, and continue injecting fluid in the artery until sufficient fluid is used to satisfy you of perfect circulation.

The amount of fluid varies in each case just as the blood of each case varies, as well as the age, and there is also a still further difference of conditions warranting greater or less fluid used. The sooner a body is embalmed after death, the greater caution is necessary not to use too much fluid, while if a body remains from four to ten hours after death before it is injected, scarcely any danger of "appearance of over-embalming" will occur, and therefore a greater quantity of fluid may be used, which often gives the greatest satisfaction to the operator.

When you have completed the injection according to your own judgment, withdraw the nozzle, ligate the artery and sew up the incision.

### HOW TO LOCATE, RAISE AND INJECT THE FEMORAL ARTERY.

The Femoral artery, on account of its size, and as it is the principal trunk artery of the lower limbs, is used by embalmers with the Iliac artery with more or less frequency, and whatever is said of one applies to the other.

The Profunda is a branch lying directly alongside of it, and is frequently mistaken for the Femoral. There is but little difference between them, and while injecting towards the body it does not matter whether one or the other is used. Injecting towards the foot, however, it is very important that the Femoral artery, which lies closer to the surface, be used, because it alone extends to the knee, and there on to its branches, conveying both blood in life and fluid after death to all of the flesh tissue in the extremities of the leg, and as this Femoral artery is used mostly for direct circulation in the leg, it is important, indeed, that this be the chosen artery, because it is used principally for the sole injection of the thigh and leg.

It is advisable to raise this artery as high in the limb as it is possible for the operator to do, and therefore I would advise the use of the external Iliac artery.

The Femoral artery is the continuation of the external Iliac artery (F, back plate Body), and enters the thigh from its continuation after passing over the crest of the Ilium (39, back plate Body), and under Poupart's ligament (31, Muscle Plate). Immediately upon its entrance into the thigh it becomes the Femoral artery. It pursues a spiral course, and continues down to the lower third of the thigh, when it becomes the Popliteal artery (H, plate 5, Lower Extremity).

The Iliac lies closer to the surface than does the Femoral, because it comes up over the Ilium bone, under Poupart's ligament, and at this region lies just half way between the Pubic bone in the front and the head of the Femur bone. An incision through the superficial fascia 1 or 1½ inches is sufficient, and with the use of the blunt aneurism needle it may be easily found and brought to the surface.

Injecting downwards into this artery fills all of the branches of the external Iliac and Femoral arteries. The

upper ones supply the entire thigh, and, indeed, curve upwards, extending around over the lower part of the abdomen, and therefore are of great importance in injecting the extreme parts on a body, particularly one that has been posted. A trial of this will show how complete this circulation is, particularly on bad cases, where the green color of decomposition has been marked throughout the abdomen. Just below that point the Femoral artery begins, and about 1½ inches below Poupart's ligament it gives off a branch almost as large as itself, which supplies the tissues in the thigh and circulates through its many branches.

The Femoral artery can be located about the middle of the thigh and between its great muscles, about two inches below Poupart's ligament. In making your incision, therefore, you mark out your course from about two inches below the center of Poupart's ligament, near the middle of the thigh, and dissect perhaps an inch or an inch and a half down through the soft tissues that you come in contact with.

Divide and cut until you come to the large muscles of the thigh, then separate and place them on either side, after which you will discover the Femoral and Profunda lying side by side, accompanied by the Femoral vein, the venæ comites, two in number, and the great nerves of the lower extremities. Your greatest difficulty will lie in separating these one from another, but care will accomplish it.

After separating the Femoral from the Profunda you can raise either one to the surface and pass your ligatures around it, as explained in the case of the Brachial artery, one on each end, and allow them to hang loose until you need them.

If it seems wise to tap the vein in this instance, it can be done, as in the Basilic or Axillary veins, first, however, having raised the vein to the surface and having the vein tube properly placed.

Attach the tubing to the nozzle that is placed in the canal of the artery, inject slowly at first, but with a quicker motion as you proceed, though never hurriedly.

This description for the injection of the Femoral artery with the use of the vein tube is intended, of course, for the injection of the body when no post-mortem has taken place, and when the injection is being made towards the trunk of the body. The vein tube is only used here when it is not used elsewhere, and when the case warrants the withdrawal of blood.

There is some discussion about the withdrawal of blood, as to when it is necessary, etc. One's own good common sense and judgment has to dictate this. There are certainly some cases where no blood need be relieved, because sufficient fluids may be injected in the arteries to preserve the body indefinitely, and there is not sufficient blood in the vascular system to retard the circulation of the fluid or to discolor any of the exposed parts, the face and hands; but in cases of sudden death, of well developed people, the blood, in some cases, occupies so much space in the systemic circulation that it does not admit of a free, thorough circulation of the fluid, particularly through the capillaries at the extremities of the body.

Pressure on the arteries is not so great at the extremities as it is near the point of injection, or at the center of the body, the beginning of the circulation, and particularly is this so where the valves of the veins, as in the neck, do not prevent regurgitation of the blood through them (backing up of the blood from the veins to the tissue.) When the circulation of the fluid through the tissue for disinfection is prevented, allowing the blood and fluid to remain in the tissue, thus producing first a flushed appearance (and the longer the body remains the darker and more unnatural this

makes the complexion), in such cases it is well for us to realize that it is contrary to nature for "two things to occupy a single place," and it is desirable to have in the tissue of the face, as well as elsewhere, clean, clear fluid that produces no color whatever, instead of blood, or even a mixture of blood and fluid. Therefore, in all such cases it is wise to allow the blood to drain from the body, which will prevent the flushed condition described.

## HOW TO LOCATE, RAISE AND INJECT THE POSTERIOR TIBIAL ARTERY.

The Posterior Tibial artery is very seldom used. This artery (lower part of plate 5, Lower Ext.) is a continuation of the Popliteal (plate 5, Upper Ext.) and descends on the inside of the Tibia bone. At its beginning it is quite deeply seated, but becomes superficial as it descends toward the internal ankle. It then passes into the foot and ravels its internal edge, crosses over under the sole of the foot, and communicates with the Plantar artery and the Internal Tibial artery.

At the point of incision, the Posterior, while superficial is quite small, and yet is frequently as large as the Radial in the arm. The incision must be made about two inches above the internal ankle, and about one inch below it in a direct line.

The point of incision should be midway between the internal ankle and the tendon of Achilles (No. 19, plate showing points of injection), which is the large tendon running up from the back part of the heel to the large muscle at the back of the leg.

The location is plain, and the injection easy. The Artery is readily reached by dissecting down. It is available for use in most cases. This artery is treated just as are the

INJECTING AXILLARY ARTERY; DRAINING BLOOD FROM AXILLARY VEIN THROUGH SPIRAL VEIN TUBE.

others. Point the nozzle upward toward the body, injecting very slowly at first.

At the completion proceed as ordinarily. Never use this artery in severe cases.

### HOW TO LOCATE, RAISE AND INJECT THE RADIAL ARTERY.

The Radial artery is seldom used, on account of its small size and distance from the heart. Other points are far superior to it in this respect, so that it has lost nearly all of the popularity it once had.

This artery (B, plate 4, Upper Extremity) is a branch of the Brachial (A, plate 4, Upper Extremity), and begins its course at about the elbow joint, and extends along the forearm to the wrist, where it runs into the hand and anastomoses with its arteries.

It is by this artery that physicians feel the pulse at the wrist. By means of its being very near the surface at this point, its course can be readily located and traced.

For the purpose of embalming it can be raised just at the beginning of the wrist and at the end an inch or so up towards the elbow.

It can be easily located in the hand or wrist by holding the hand with the palmar surface upward, and feeling along the wrist on a line with the thumb, outside of the tendon.

Having located its track, make your incision through the skin and separate the fascia with a dull or blunt instrument.

Raise the artery, pass your ligatures under it, leave them hanging loose, tap it with the point of your scalpel, and introduce your nozzle into the canal. Ligate the nozzle, and be sure the ligation is firm, as the radial artery is small, and will not bear the passage of much fluid through it at one time. For this reason there will be a strain on the pump and

nozzle all the time you are at work. Still, with care, a body can be enbalmed through the Radial artery.

After your injection has been completed, proceed in the same manner as with other arteries, except that more care and attention must be paid to the closing of the wound at the wrist, as it is imporant to hide all evidences of your work. The neatest and best way is by means of a very fine needle with fine sewing silk to sew up the wound, using great care, taking very small stitches, and drawing the lips of the wound firmy together. Never allow them to overlap each other. When your sutures are finished, place a very small piece of flesh-colored court plaster over them, and sprinkle flesh powder over the whole surface, making the part look as much like the rest of the arm as possible.

## GENERAL DIRECTIONS FOR ARTERIAL EMBALMING.

It is desirable to have a body on an embalming board, or couch, as it is more convenient to get around, and also because the proper elevation can be given to the body. It is surely desirable to take advantage of the laws of gravitation, to drain the blood away from the head and face by elevating the shoulders and the head, so that at least all of that part of the face which is exposed, to the back of the ears, is at a higher elevation than any other part of the body.

There is no fear of fluid running away from the tissue after it is once circulated. The capillaries through or into which the fluid must get to disinfect the flesh tissue are so small that it would be an impossibility for the fluid to run out again through the arteries, and if it passes on through the veins it has so thoroughly disinfected the flesh tissue that no decomposition can occur.

After a body is thoroughly embalmed, it is important that

the cavities as well as the mucous membranes of the nose, mouth, and eyes be cleansed and disinfected. A little cotton moistened with fluid, held with a pair of forceps, should be used beneath the eyelids. Injection of fluid through the nasal tube should be made in the mouth and nose, and enough fluid injected therein to fill the trachea and bronchial tubes. After they are filled, the Adam's apple may be manipulated so as to admit of fluid going therein, and if the body has a cadaveric odor, which is very often the case, this may be easily and nicely taken care of by bathing it in fluid. Disinfecting both the inside by arterial injection and the outside by washing, will produce sanitary conditions desirable in all cases.

## SPECIAL TREATMENT FOR DIFFICULT CASES.

Under this subject there are constantly new and better ideas and methods advanced. In ordinary cases general anatomy guides the operator to usual success, while each and every stage permits some new or different action or method in the bad cases. To get the best results one needs not only good judgment, but experience as well.

One thing which should always be remembered is that it is necessary not only to have the proper application, but to have a fluid which is a disinfectant, which destroys the germs of decay as well as changing the albumen of the tissue as food for embryonic bacteria to develop on, which continues the degeneration of the substance. When you know you have this kind of fluid, your first and universal efforts should be to get sufficient fluid distributed properly, and in sufficient quantity in all cases. The intelligent application of fluid in the various cases leads to certain success.

## HOW TO EMBALM A CASE OF CONSUMPTION.

First conclude from the stage of Consumption whether the lungs have been wasted away by the disease, and whether pulmonary circulation, as well as the systemic circulation (by the bronchial arteries) is destroyed. If so, then it is often the case that in this disease the tissues are so weak that but little pressure develops leakage. Then it is best to use the Carotid arteries.

After injecting down towards the body with sufficient fluid, inject both the Carotid arteries towards the face. As the face is the most important exposed part of the body, it is necessary to distribute enough fluid there to preserve it until the funeral, or for all time. Having this done, the embalmer feels sure that the part which he wishes to expose at the funeral will be perfect. The injection towards the body is sufficient to be made through one artery alone. These arteries enter the aorta close to each other, and it would be useless to divide the quantity of fluid and inject it through both of them, as through either one it would reach the same parts of the body.

In the event that purging is produced from the lungs, through the trachea, before sufficient fluid is injected in the body, care for this purged liquid by absorbing it with cotton or a sponge, and when it is excessive place the nasal tube on the aspirator and drain from the throat into a bottle, and continuing the injection would prove by the distention of the superficial veins throughout the body whether circulation was had to a sufficient degree to hold the body as long as desired. If not, it might be necessary to inject the Brachial arteries towards the hands, and the Femoral arteries towards the feet, and hypodermic the body with a medium sized perforated needle. This, however, would not be war-

ranted on the first day, or, indeed, until conditions would prompt such heroic treatment.

It is rare, indeed, when a lesion will admit of sufficient leakage in Consumption to prevent the circulation of the fluid anywhere except in the face, and your injection through the Carotid arteries upwards will relieve any anxiety in this respect.

In Consumption cases there is seldom sufficient blood to warrant draining it from the body, and with the exception of the thoracic cavity and upper extremities there is little likelihood of any trouble, because of the thinness and scarcity of blood and tissue.

Care should be exercised, as in many cases of Consumption the lungs have become decayed. Application of the fluid needs to be made through the nose into the trachea and into the bronchial tubes. The fluid also needs injection through the needle in Consumption of the Bowels, Lingering Consumption and Hasty Consumption. All these cases require special care. The contents of these emaciated frames is generally a mass of decomposing material, forming gases and threatening the whole body with premature decay. Such cases are desperate ones, and require prompt and heroic treatment.

The Carotid artery is preferable for this class of work, as the fluid is easily forced from it throughout the entire system.

Follow the injection of the artery with the customary treatment of the thoracic cavities; perforate the diaphragm from the point at the naval as usual, and inject at least a quart of fluid into this cavity, or more if you can do so without too much distention. Then extract the gases, and inject the fluid.

If properly embalmed, a consumptive body may be pre-

served for a week or ten days as readily as for two or three days.

The embalming process in cases of Consumption improves the appearance of the dead.

Arterial embalming should be employed in all cases; and where decomposition has set in, cavity embalming may be done in conjunction with it. Whenever the bowels are the seat of trouble, such heroic treatment is required.

In such advanced stages of decomposition, the abdominal cavity should be treated with a liberal quantity of fluid, as gases form very rapidly. It is more than likely that on your arrival at the house you will find the body purging, the abdomen very much distended, the subject, in fact, decomposing rapidly. Place the body properly on the board at high enough elevation so that for the time being purging will cease, allowing you to proceed with raising the artery and starting its injection. Should it commence to purge, it is time to use the trocar to puncture the transverse colon, or perhaps the stomach from the abdominal insertion of the trocar, aspirating and using all means at your command to assist the escape of the gases, after which the purging will cease, the body will assume a more normal condition and have a free circulation. Embalm through the Carotid artery in all such cases. In fact, whenever the subject is in bad condition, the greatest safety lies in arterial work.

A collateral benefit arises from raising an artery in consumptive cases. It is this: that as there is usually only a small depth of tissue or fat to penetrate, the artery is easily and quickly reached, and a certain familiarity and expertness in the work gained at small expenditure of risk or effort. In such cases practice feeling of, and familiarizing yourself with, the artery. It will be good drill for you.

INJECTING CAROTID ARTERY (nearly finished); ASPIRATING BLOOD THROUGH CARDIAC NEEDLE FROM THE SUPERIOR VENA CAVA.

## HOW TO TREAT A CASE DYING OF PNEUMONIA.

To embalm in cases of Pneumonia, follow about the same methods as in Heart Failure, Asphyxiation and Apoplexy. Pneumonia is an inflammation of the tissue of the lung. The lungs, therefore, are the seat of the disease, with the pulmonary circulation impaired, and as this circulatory system influences the systemic or functional circulation of the body, the embalmer finds that in a majority of the cases the blood has produced a coloration in the face and neck, therefore, to best embalm such case use the axillary artery and the axillary vein, which will allow the draining of the blood before or at the time the arterial injection is begun.

Pneumonia varies from Consumption in this particular respect; as it is a disease which usually causes death from *short illness,* consequently it is quite natural to find an excess of blood which needs to be relieved, therefore, use the new axillary vein tube, easily accomplished when using the Axillary artery for injecting the fluid, because at this same incision the vein may be used to enter the vein tube.

The question might be asked: "Why not use the Jugular vein and the Carotid artery?" This would be all right in the morgue, or where the body is not surrounded with clean clothing or linen, but in a private home, where so many of these cases must be treated, the operation of raising the Jugular vein is more or less likely to be attended by troublesome leakage of blood. On account of its location it is very difficult to manage this without leakage, but with the vein in the arm, even though it should leak, it is very convenient to have a rubber cloth or apron placed beneath the arm, and with cotton or sponge absorb the leakage.

It is highly important that the blood be considered in the injection of Pneumonia cases, because in the congestion of

the lungs previous to death the blood is darker than in ordinary cases, therefore its presence in the tissue produces the worst kind of discoloration.

Pneumonia cases frequently become flushed from the injection of fluid, and in every case the operator should be prepared to drain the blood through a vein tube, or if preferred use a perforated needle, rupturing the superior Vena Cava, entering between the second and third rib on the right side of the Sternum bone. If the hollow needle be used, it should always be after injecting a certain portion of your fluid. By injecting first, you establish at least a partial circulation and feel satisfied regarding its preservation, and also liquefy the blood so that it will run freely through your needle when you start to aspirate it.

*Pleurisy* can be treated in the same way, as it is closely allied to lung diseases, and oftentimes Pneumonia develops Pleurisy. In such cases there is a Pleuro-Pneumonia, which may be treated in the same manner.

To embalm a body dead from either Heart Disease, Alcoholism, Paralysis, Poisoning, Sunstroke, Heat Cases, or Sudden Death Cases, and whenever blood is excessive, proceed by injecting through the Axillary arterial tube, draining the blood from the Axillary vein, as in Pneumonia cases.

### SUNSTROKE, OR HEAT-CASES.

Here a peculiar condition exists, usually in heat cases. The temperature rises previous to death to a higher degree than in any other cause of death. It is not infrequent to find the temperature 110 degrees, and after death the temperature is likely to increase a few degrees, and special caution should be observed because the embalmer realizes that "heat and moisture" are the two principal elements that hasten decomposition.

With the excesive heat, decomposition is likely to proceed very rapidly, especially when the circulation is also somewhat interfered with by the congestion of the blood in the tissue. It is a safe plan to use at least twice as much fluid on these cases as ordinary ones, and continue the injection and manipulation all over the body with a wet sponge so as to stimulate the free circulation of the fluid in the capillaries. The injection of a large quantity of fluid makes it necessary to relieve the veins of the blood which they usually contain in great abundance, and it is best to drain the blood from the veins. Use a trocar to draw from the Vena Cava, if you prefer this method.

There also may be conditions to treat afterwards, where circulation has not occurred, and when decomposition sets in. This may be readily taken care of by the injection of fluid in the arteries again, or perhaps by hypodermic injection with the proper sized needle, according to the amount of surface to be treated.

It may be advisable in such cases to embalm in the Carotid arteries, injecting both of them upwards (after injecting the one down), as by this application a sufficient quantity of fluid is distributed through the face tissue to preserve it for all time, thus obviating the necessity of any later treatment of it.

Cavity injection is also necessary in such cases, on account of there being an abundance of vegetable substance (food) in the stomach and intestines, which is apt to ferment; indeed, it is likely to start fermentation while the high temperature yet remains in the body.

## HOW TO EMBALM A BODY DEAD FROM TYPHOID FEVER, AND LOW TYPE FEVERS.

While on our guard at all times, in low type fevers we should be especially so, as they are difficult cases to handle. Heroic treatment from the beginning is required.

Disinfect the exterior of the body, the body clothing, and also the bed clothing.

A body dead from Typhoid Fever generally emits a discharge from the anus, which should be immediately disinfected, as it is in this that the deadly contagion lurks. Remove at once, and pack something in the anus.

Cotton saturated with a disinfectant, and forced into the rectum through the anus, is a practicable method of preventing disagreeable discharges. But, if that does not suffice, ligate the anus. First having drawn it out with your sharp-pointed embalming hook, pass a string around it and tie it in double hard knots. You will not be troubled further from this source.

Wash and inject the body, as in any other contagious and infectious case. When embalming Typhoid Fever cases, it is best to use the Axillary arterial tube for injecting the fluid as a more even circulation is thus obtained. Frequently it is of great advantage to the good appearance of the body to drain the blood. It is best to use the Axillary vein tube for this purpose, or else wait to draw the blood until the body has been partially embalmed arterially, when you may insert a cardiac needle between the second and third rib, rupturing the Vena Cava and draining the blood in that manner from the body. Disinfect the blood thus drained by using one-third part full-strength fluid.

The New Transportation Rules require the cavity injection of Typhoid Fever cases. As the seat of disease is in

the small intestines, a thorough injection of the abdominal cavity is necessary.

In Typhoid Fever cases, the principal substance most infectious is the stool, or discharge from the rectum. Therefore, be sure to use precaution. Thoroughly disinfect this fecal matter as described for disinfecting the blood. Follow this method in all low type fevers, as they vary little.

HOW TO TREAT A CASE DYING FROM A HEMORRHAGE.

To embalm the body of a person who has died from a hemorrhage of the lungs, involves the same treatment as in consumptive cases. The body is more easily preserved, however.

You are not compelled to withdraw the blood, as this has drained from the tissues during the hemorrhage. Simple, ordinary methods answer all purposes, substantial treatment of the cavities being all that is really necessary.

But in cases of *Internal Hemorrhage,* you have to apply all the means at your command, for the blood has escaped into the cavities of the body, and prompt and heroic treatment is needed.

Thoroughly inject the arteries in such manner as to insure its even distribution throughout the body, particularly the extremities of the exposed portions.

Death from hemorrhage indicates ruptured arterial or venous circulation sufficient to occasionally necessitate the injection of the arteries towards the extremities, the same as of an autopsied case. Aspirate the blood and water from the cavities where it has collected, and inject fluid into these cavities to thoroughly disinfect their contents.

## TO EMBALM A BODY DEAD FROM DROPSY.

Arterial injection is always necessary to properly embalm dropsical bodies, as they cause the embalmer the greatest anxiety.

Edema, cellular dropsy, is the kind of dropsy which most attracts the embalmer's attention. Dropsical water in the tissues of the lower limbs and also of the upper extremities causes their distension to so great an extent, that it is difficult to secure free and even distribution of fluid through these parts by the ordinary process of arterial embalming, therefore preparation should be made at once for the draining of this liquid from the body during the time of the arterial injection of the fluid and for the embalming of such cases the axillary artery and vein are found to be most satisfactory. During the injection of the embalming fluid, and while the blood is allowed to drain from the body through the vein tube, the position of the body will aid the embalmer much in his successful operation by elevating the limbs, the natural law of gravitation will carry all liquid secretions which are forced by manipulation and pressure, with the hands, or with rubber bandages, which forces this material from the tissues into the veins and drains through these veins into the vena cava, from whence it may be drained out through the axillary vein tube. As a considerable quantity of this liquid secretion drains through the lymphatic circulation and through the thoracic duct, which empties at once into the subclavian veins. The great advantages of the selection of the axillary vein to secure the best results are at once apparent. It is always an advantage to drain as much water as possible from the body either before or during the injection of fluid therein, because if this water is allowed to remain in the body, it

will dilute the embalming fluid in exact proportion in which it exists therein.

It is true it is difficult to remove, indeed impossible, to drain all of the dropsical water from the body, nevertheless, a goodly portion may be drained from the surface tissue; this gives place for the fluid to circulate the more freely through the extreme branches of the arteries to the capillaries, throughout the surface tissue, so that preservation may be assured and skin slip and dropsical blisters prevented. Dropsical water contains sithate of ammonia, a slightly alkaline substance, which causes fermentation and putrefaction, which to some extent destroys the lesions which hold the skin to the superficial fascia, therefore it is of the greatest value to accomplish thorough circulation of fluid through this substance, to prevent the annoying conditions which usually prevail about the dropsical body.

In dropsical cases, formaldehyde is to the embalmer what nitroglycerine is to the miner. Used in proper proportions with hydrogen Per Oxide, the tissue becomes firm and dry. At one time the idea was advanced that ammonia neutralized formaldehyde, and that in consequence, formaldehyde was not a suitable substance to use in embalming this class of cases. Further experiments, however, proved that formaldehyde was an ideal chemical to be contained in embalming fluids and that ammonia was not a very energetic reagent and did not interfere with its efficiency.

When applying bandages on the limbs, start wrapping them at the feet and continue to the thigh. These bandages should be left on at least fifteen minutes with the limb elevated, so that the dropsical water and secretions may drain from the tissue, through the capillaries and into the veins which empty into the vena cava and from there may be drained in the usual method through the axillary vein

tube. The rubber bandages should never be allowed to remain on the limbs while injecting fluid, because this pressure would cause resistance to free circulation of the fluid through the branch arteries to their extremities, and through the capillaries.

After draining all of the water possible away from the extremities, the embalmer should continue the injection of the fluid until all of the signs are produced to prove the thorough circulation of the fluid throughout this tissue. This is usually accomplished by the single injection through the axillary artery, but should there be tardy circulation, it is beneficial, especially in the summer time, to raise the iliac arteries and inject fluid into them towards the extremities, as by this means you may be sure to circulate fluid by this direct injection in sufficient quantity to produce the desired conditions. It is also well to consider that in all dropsical cases there still remains in the body a considerable quantity of dropsical water, even though a great amount has been drained from it. This dropsical water, which is contained in the tissue, would naturally dilute the embalming fluid, therefore it would be proper to increase the strength of the formaldehyde solution by adding Primerine or formaldéhyde; use a pint to each gallon of fluid, to take care of the average dropsical body. By so doing the strength of this fluid will be sufficient, even though it be diluted with considerable dropsical water, to produce the best results.

In many dropsical cases, the abdominal cavity contains a large quantity of dropsical water and should be drained away. Use a hollow needle or cavity drain tube. Insert it through the abdominal wall and aspirate all of the liquid secretions therefrom. If a great quantity is present, causing the distension of the abdominal walls, previous to

or during the arterial injection, this dropsical water may be drained from the cavities early in the operation of embalming to allow more free circulation of the fluid through the arteries to the tissue over the trunk of the body. If a sharp needle is used, this operation should follow the arterial injection, as there is always the danger of rupturing the arterial circulation by a sharp needle, and this would be too great risk to take in dropsical bodies.

The quantity of fluid necessary to properly care for a dropsical body depends largely upon the size of the body, also on the length of time the embalming after death has occurred (more fluid is needed under these circumstances). also the probable dilution of the fluid by the amount of dropsical water remaining in the body. Sufficient amount of fluid must be used to fill the large and small arteries and also all of the capillaries, and as the circulation of fluid throughout the extremities is somewhat retarded by the disease, therefore it is necessary to produce more pressure to secure capillary circulation than on many other cases. For shipping cases and those bodies which are kept for several days in warm, sultry weather, a gallon of good strong arterial fluid should be used to every one hundred pounds of tissue. The cavities, also, should receive fluid in reasonable proportion to the amount of liquid secretion drained therefrom. Cloths should be saturated with embalming fluid and should be wrapped around the limbs as a further precaution against skin slip.

These are the most exacting of all cases, and require skill and perseverance.

First, elevate the body on the embalming table as high as possible without causing it to sit upright, and let the body remain in its elevated position a few moments so as to get all the water (the dropsical fluid) into the abdominal cavity.

Take the point of your knife and cut through the skin, or use your dropsical trocar instead, the only disadvantage attached to that instrument being its sharp point.

But, if the case is a bad one, the long, blunt perforated needle is the best instrument by far, and should always be used, because with it there is no fear of rupturing the arteries and spoiling the arterial circulation. Pass it hither and thither, anywhere and everywhere, its great length permitting you to penetrate the abdomen from top to bottom and from side to side. You will extract the gases at the same time that you are extracting the dropsical fluid.

Attach the tube to the head of the needle, rigging the pump on the opposite side. It will require perhaps an hour for the removal of the dropsical fluid, the abdomen diminishing in size as the water leaves its cavities.

Now raise an artery—the Axillary answers very well, or the Carotid. If there should be any discoloration about the face, neck, or shoulders, use the Axillary vein tube without fail. In fact, while the water is leaving the abdomen, once well started, let it attend to itself and look for the artery, thus saving time, though the operation will be long and tedious at best; yet you should omit nothing.

Prepare your ligatures around the artery. When the abdominal cavity shows signs of becoming empty of water, begin to inject the arteries, still allowing the long needle to remain in the cavity. Inject as slowly as possible at first, increasing your speed as you advance. Inject perhaps from three to four quarts of fluid into the arteries. Then care for the case as in any other case of embalming. Should there be no change next day, leave everything alone; but, should there be much water in the legs, it is best to wrap them with rubber bandages, starting at the foot and proceeding upwards as far as the swelling extends, leaving them this way

for half an hour, forcing some of the water from the extremities, then take off the bandages and rub the legs well while you continue to inject fluid. This produces circulation there which otherwise would not be obtained.

In the absence of rubber bandages, linen bandages may be used, but taking them off and putting them on several times is much better than just once, because just as soon as a little compression has benefited, the pressure ceases to exist, and they are of no avail. Better than either of these is the pressure that one is able to give with the hands over this entire tissue. It not only forces the dropsical water from the tissue, which is carried by the veins into the body, but assists and assimilates the circulation of the fluid into the tissue.

It is an advantage, also, where there is dropsical water, to increase the strength of your fluid by Formaldehyde and other substances so that it still has its proper strength after the dilution which the dropsical water causes.

By a thorough and proper manipulation, the fluid, if strong enough, may be circulated throughout the entire tissue so that blisters will not form nor the skin slip. Use plenty of fluid. Two or three gallons is not a large quantity for arterial and cavity injection, but the amount should be gauged according to the condition and size of the body.

On limbs that have already been opened and are oozing, one of the nicest applications is Plaster of Paris. Place a towel beneath each limb. Four or five pounds of Plaster of Paris spread over this towel and carefully placed around each limb absorbs the moisture, dries, and hardens, and as it is an antiseptic, being a preparation of lime, it produces the most sanitary and hygienic conditions.

## TO EMBALM A BODY DEAD FROM CHILDBIRTH.

These are difficult subjects to handle. Ordinarily you will need an able female assistant, as there is much delicate work to be done. Immediate attention is required. The arteries should always be used. On no account trust to cavity work alone. Should there be dislocation, remove it by tapping the vein accompanying the artery.

Care should be exercised that there be no leakage from the uterus (womb). If there should be, require your female assistant to fill with cotton and close as tight as possible, and bandage with a napkin. Should the leakage continue stubbornly, use your aspirator to drain from the pelvic cavity into a bottle.

Continue the injection into the arteries; you will find the fluid leakage will not equal the amount injected, therefore showing that a part of the fluid that you are injecting in the arteries is going to the flesh tissue, hence you have encouragement to continue until sufficient fluid is used to embalm the body thoroughly.

Examination will show whether you have enough fluid in the face, and if you have not, inject the Carotid arteries on both sides, and if afterwards you find that there are some parts that still need an injection (indicated by decomposition), it will not be the face, for the Carotid artery injection towards the face always preserves it, so no fear for the *exposed parts* need be entertained. Such soft and degenerating tissue appearing upon the trunk of the body, particularly over the abdomen, may be treated by a hypodermic injection of fluid therein.

After this, proceed with the abdominal cavity, where you must be very particular, and equally so with the upper portion, as both are involved in the disease. The upper in-

cludes the breasts, which are full of glands and veins containing milk, which requires immediate attention, as the gases will form very rapidly.

Always elevate the head above the level of any other portion of the body, and keep it in that position until ready to be placed in the casket.

In case the child remains in the womb after the death of the mother, it need not be removed, because a good cavity injection in this region will preserve it. This is necessary, as you should not depend on fœtal circulation. It does not exist in the passive condition of morbid anatomy.

### TO EMBALM A CASE OF PERITONITIS.

In cases of this nature, use either one of the most important arteries, and proceed as directed in childbirth cases. It is best to drain the blood, therefore the Axillary Artery is preferable to thoroughly embalm the tissues of the body.

As the seat of this disease is the bowels or intestines, without doubt they will be badly distended with gases and need immediate attention, as the skin is becoming discolored, and it will readily appear that decomposition has set in and must at once be arrested.

Aspirate the gases and secretions from the abdominal and pelvic cavities.

These gases are in some instances extremely poisonous, and always disagreeable, therefore neutralize them at once, by having some fluid in the aspirating bottle. Disinfect the secretions; it is best to convey the gases out of the room by using a ten foot piece of small lightweight rubber hose attached to the injector nozzle of the aspirating pump, with the other end of the hose placed outside the window. This method of disposing of the gases is to be desired in all cases, particularly when the corpse is in a room in which there are

curtains or draperies and upholstered furniture, which absorbs and retains bad odors, also any infection or contamination from any of the communicable diseases.

These gases, aspirated from the body into the room, always produce a bad odor, and while the embalmer soon becomes enured to it, and even forgets, its presence is very objectionable to any of the relatives of the deceased who are frequently invited by the embalmer to inspect the body before taking his departure, under such circumstances. The first impression received by one entering the room is of the bad odor produced by carelessness of the embalmer, whereas, had these gases been conveyed out of the room, a pleasant odor of the fluid or of some perfumed disinfectant would have created at once a first and lasting favorable impression of the embalming and of the undertaker's great care or consideration.

Inject all the fluid possible into these cavities.

It may be necessary to extract the fluid on the following day and replace it with a fresh supply. Never trust to cavity work alone in bad cases, no matter what the cause of death may have been, even though the body is to be interred the following day. Always do arterial embalming in these cases.

### HOW TO EMBALM A BODY DEAD FROM GUN-SHOT WOUNDS.

Locate the wound and probe for the ball if it has not been already extracted.

Ascertain whether there has been much hemorrhage, and also if any of the arteries have been severed. You will know what course the arteries take by a reference to the plates of the Aid.

Ascertain also if any of the viscera, and what part, have been penetrated.

EXTERNAL ILIAC ARTERY.

Inject fluid into the wound, and let it run out, or, if it remains in the wound, you will know that the bullet has entered and lodged in one of the cavities of the body and left a canal to its bed. Then place a wad of cotton in the wound and take a stitch or two in the opening, thus closing it and imprisoning the fluid you have injected.

If the ball has entered the head, use the Carotid artery (19, Head section, Aid).

By injecting downwards through the Carotid, you take care of the body just the same as in any other case, but by injecting upwards you have the opportunity of watching the fluid and injecting as fast as necessary.

You always get more in than will run out of the wound, therefore the excess of the fluid is going to the flesh tissue of the face, and when any is leaking out, it is going from the ruptured arteries in the tract of the wound. You need to always watch carefully, however, that you do not distend the face and swell the eyes.

It is not likely that sufficient fluid will run from the wound to leak more than a bulbful or two at most, and therefore an excess of fluid may be easily had in the face.

Embalm the body as you would in any other case, and follow the directions given for embalming through the Carotid artery. These are not always difficult cases, as hemorrhage may save time that otherwise you would have to expend in aspirating the blood.

### TO EMBALM A BODY DEAD FROM DROWNING.

First empty the body of the water that has passed into it during its period of immersion.

In cases of drowning, the blood remains fluid, and decomposition begins at the head and works its way downward.

Force all the water out of the body, then proceed as in any case of arterial embalming, providing there are no indications of capillary gases or decomposition.

Very often drowning cases are really cases where death has been caused from shock, when little or no difficulty will be found in preservation; but where the body, after lying in the water for some time, has come to the surface because decomposition has set in, producing capillary gases which make the bulk of the body lighter than its equal bulk of water, then the embalmer should know that he has indeed a task before him.

Wherever capillary gases exist in the tissue, there it is difficult to get circulation, and indeed it is almost impossible to do so, all over the body, by *general circulation.*

In such cases it is best to use both Carotids to the head, using constant manipulation to stimulate its circulation throughout the tissue of the face, and by the same means force the gases away from it, and it may be well to rupture the Jugular veins. You are warranted in taking heroic measures under these circumstances.

In treating the other extremities, it is necessary to use the Brachial or Axillary arteries, to inject *towards the hand,* and it may also be necessary to use either the Iliac or Femoral arteries to inject *towards the feet,* and also to use a sharp perforated needle as a hypodermic all over the Trunk of the body.

It is always well to inject one of the Carotid arteries down towards the body, and use two or three times as much fluid on such cases as in ordinary cases.

Some of the worst swelled bodies may be treated in this way, and in two or three days brought back to a normal state of preservation, almost wholly reduced in size from the swelling and with the odor entirely relieved.

Where the skin has been peeled off the face or hands in such preserved body, it may be tinted and the discolorations covered, and if laid under the light properly maybe presentable and altogether satisfactory to the family.

Puncture the stomach and bowels in the lower cavities, and the pleura in the upper, then inject with perfect freedom. Cover with saturated muslin, as usual, and place the body in its casket.

### APOPLEXY CASES.

A thorough knowledge of the systemic circulation leads to the natural conclusion that the short, heavy, apoplectic bodies, and indeed, in all sudden death cases, the blood should be drained from the veins while fluid is injected into the arterial system. It therefore is most convenient to inject the fluid in the axillary artery and drain the blood from the axillary vein, as the embalming fluid naturally follows the lines of the least resistance until it is checked in yielding at the semi-lunar valve, and therefore gradually fills up the aorta and all of its branches before it passes from them to the sub-branches, into the capillaries and tissue.

A long axillary arterial tube which will convey fluid directly into the arch of the aorta will aid the embalmer in distributing this fluid through the branches of the aorta more evenly. This is a great advantage in apoplexy cases, as clear fluid beginning its circulation in the carotid arteries at the arch of the aorta will by an even pressure, circulate to the extremities of these arteries and have greater influence upon the circulation of blood from the capillaries than could be obtained by any other method of injection, except perhaps the use of the carotid arteries, directly injecting the fluid through both of them towards the face. As the axillary artery is found in the same incision as the axillary vein, this single

incision method has proven the most satisfactory way of embalming these cases. Make the incision through the hair line over the axillary artery and vein, about two inches in length, separate carefully the artery and vein as described elsewhere, in the injection of this artery.

Apoplexy cases should always be arterially embalmed, indeed, it is the only safe and sure way of forcing the blood from the capillaries. No special precautions in embalming apoplexy cases are necessary excepting to properly take care of the blood. The only abnormal condition of the vascular system is a distension of some of the blood vessels of the brain, which are supplied through the branches of the internal carotid arteries. As these do not interfere with the circulation of the blood through the branches of the external carotid arteries, thorough circulation in embalming may be as easily done in apoplexy as in any other cases. The blood should be allowed to drain from the vein tube at the same time that fluid is injected into the artery. A quart of embalming fluid should be used to each fifty pounds weight of the body, and in addition to this, as much more fluid should be injected into the arteries as blood is drained from the body. During the injection of the fluid, a soft sponge should be used over the face, neck and ears to force the blood through the capillaries and also stimulate the circulation of the fluid throughout this tissue. In the absence of a soft, moist sponge use your hands for the massage treatment of the tissue. In the first treatment of an apoplexy case, if the injection of the axillary artery fails to give the desired results by the injection of the quantity of fluid you have planned to use in the body, and if after you have injected through the axillary artery the larger proportion of fluid you have along with you and fail to clear the tissue of the blood, it then would be advisable to proceed at once with the injec-

tion of the carotid arteries, rather than to allow any fluid which might be contaminated with the blood to remain in the face tissues, because the mixing of the blood and fluid together in this tissue would gradually grow darker and the longer it remains, the more difficult it is to remove.

Apoplexy cases may be embalmed as easily and thoroughly as any other kind of bodies that require the embalmer's attention, the particular feature of the apoplexy case being to remove the superabundance of blood which must be drained from the veins, so that a free circulation of embalming fluid through the arteries and capillaries may be obtained.

### IN CASES OF DEATH BY STRANGULATION OR FROM A BROKEN NECK,

the same process should be followed. These subjects are always discolored in the face and upper parts, but the blood remains fluid, and will gravitate toward the superior Vena Cava and be readily drained therefrom through the axillary vein tube.

Suffocation, hanging and strangulation can be treated alike.

Sunstroke and Apoplexy are in about the same category.

Use the same method in all. Remove the blood-coloration by injecting through the axillary arterial tube.

### TO EMBALM A BODY WHERE THE THROAT HAS BEEN CUT.

If the common Carotid artery has not been severed, raise and use it as in any other case. If this artery has been severed, take hold of the upper end of the artery with your forceps and insert your arterial nozzle and inject therein a few bulbfuls, as in any other case, then tie the upper end, insert your tube in the lower end, and inject the fluid downward.

## TO EMBALM BODIES DEAD FROM ANY DISEASE WHERE POST-MORTEM HAS BEEN HELD.

As a rule, in these cases, the doctors increase the embalmer's difficulties. In cutting the dead body open, and in examining the viscera, a great number of the arteries and their branches are severed. Yet the gases will have been extracted during the post-mortem examination, and should the arteries be in sight, ligate (or tie) the ends, and thus get a circulation. But this is a tedious operation, and requires skill and patience.

The easiest method is to raise the Brachial artery (A, Upper Extremity plate in Aid) and inject towards the hand. This will preserve the arm, clear up the hand, and make it wholly satisfactory and preserve it from "skin slip," or discoloration by decay. Treat both arms the same way, then inject down in the external Iliac or Femoral arteries, injecting them both towards the feet. This will take care of that region of the body, and most important of all is to raise the Carotid arteries and inject them upwards on either side of the face with a small quantity of fluid, but sufficient to keep the face. Thus you will be taking care of the exposed parts of the body just as well as though it had not been posted at all.

The leakage that does occur will be from the veins into the trunk of the body. This will be blood and fluid, and it will do no harm in that region, except that if it becomes too full, you should aspirate.

The trunk of the body may be preserved by using a perforated needle as a hypodermic, and injecting throughout its entire tissue. This requires considerable more fluid than ordinary injection, perhaps two or three times as much in a posted body, but the success to be obtained warrants its use.

## "DISCOLORATION."

Post mortem coloration, which is due solely to the presence of blood in the superficial fascia, is easily removed either by elevating the head to allow the natural gravitation to drain it away, or when this is aided by gentle manipulation with the fingers, or with a sponge, it presents no serious question to the operator except that he recognizes that blood is there in excess of the usual case. Injecting such body through the arteries forces this blood from the capillaries into the veins, and when these veins become filled up, this blood should be removed or it will offer a resistance to continued free circulation through all of the tissue all over the body, or else it expands the veins, particularly those in the neck, the Jugular veins, which have but two valves, and when the vein is stretched beyond permitting these valves to meet, then they lose their controlling influence and allow a regurgitation of the blood, which is now mixed with some fluid, back into the face, which produces flushing, and should surely be removed at the earliest possible moment, because remaining there produces in this tissue a staining of the walls of the capillaries and lymphatics, and presents a color much the same as a Post Mortem Stain produces, either by decomposition or by bruises. Neither hot nor cold water is of sufficient value, nor produces good enough results for the practical Embalmer of the present day to waste time on. The Embalmer who gets his circulation knows that he can wash out this tissue either by general circulation, draining the blood, or when this flushed condition appears and is allowed to remain long enough to congest, it may then be best removed by raising both the Carotid arteries and injecting up into each side, manipulating the face while doing so, thus getting behind the red blood corpuscle, which is in the

capillary, with the fluid in the artery, forcing it ahead and into the veins, which, if relieved by rupturing with a cardiac needle, or by tapping the vein with the use of the vein tube, this color may be wholly and thoroughly removed. The use of cloths on the face is usually attended with some satisfaction. That custom was originated, however, by Undertakers who were not Embalmers. On such cases, where they did no embalming, or else just a cavity injection, it produced some benefit, more by the natural contraction which moisture causes than by any chemical effect from the liquids used.

In ordinary cases arterially embalmed, moist cloths on the face are superfluous, and if kept too long and too moist on the face they cause a peculiar shriveling and shrinkage of the skin, just as occurs when a person's hands are kept in water for any length of time, and it should be avoided unless it be on the face of a very thin person where the absorption of the moisture from the face by the atmosphere would shrink and dry it too much. Under such conditions moisture on the face, if the moisture be of such nature as to keep the skin nice and fresh, would be an advantage. A mixture of Rose Water and Glycerine is a very nice application, or in the absence of this a thorough application of an antiseptic grease keeps the skin soft and velvety and in excellent condition.

# PART SECOND.

## Instructions and Methods of Embalming.

*By Charles A. Genung.*

# PART SECOND.

## Instructions and Methods of Embalming.

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## DISINFECTION OF THE DEAD BODY.

All authorities agree that a thorough disinfection of a dead body can be accomplished only by introducing a disinfecting embalming fluid until all tissues of the body are thoroughly disinfected by the fluid. When such condition is reached the only change that can take place with the dead body is the change coming with desiccation. To produce this disinfected condition of the entire body is the object of thoroughly embalming it. I believe it possible to accomplish this condition with a body, dead from any cause. Oftentimes the embalmer, to accomplish this end, must devote hours of labor. Partial embalming may be done in any length of time, varying from a few minutes to a number of hours.

To obtain a thoroughly disinfected body, we must in each case disinfect the blood remaining in the body. To do this it is necessary in many cases to remove some blood, as in these cases the introduction, in any manner, of enough fluid to disinfect the blood of the body would distend the venous circulation, containing most of the venous blood, and such a distension would be undesirable. It is wise, therefore, to be ready in all cases to remove enough blood to prevent any such unpleasant distension.

To allow enough blood to pass out of a trunk vein of the body by means of a draining tube inserted into and through such trunk vein, until it has been passed beyond all valves

and has reached the "well of the venous blood", which comprises the right and left innominate veins, the superior vena cava, the right auricle of the heart and the inferior vena cava, has been the object of all who have invented or used any kind of draining tubes.

The Genung-Eckels draining tube is offered to the embalmer with the claim that, with it, blood may be removed in all cases that could be, by means of any other instrument, and that this draining tube is free from all the objectionable features of the other draining tubes.

The claims in favor of the Genung-Eckels draining tubes are:

1st. It will at all times remove more blood in a satisfactory manner than any other instrument.

2d. Its insertion and withdrawal are accomplished with greater convenience and can be done as cleanly as with any other instrument.

3rd. It will not bind in the vein and need never be buried with the body, as often occurs with the spiral draining tube, and will always leave the vein as easily and freely as it enters.

4th. It will not clog as easily, and if it should so clog, it may be freed better than any other instrument and without removing it from the vein.

5th. It is more easily kept clean than any other draining tube.

6th. The Genung-Eckels draining tubes are durable. One set should last a "life time".

This work, "The Eckels-Genung Method and Practical Embalmer", as its name implies, is a book describing practical methods of work that should aid the practicing embalmer and undertaker in his daily experiences.

We desire to call the reader's attention to Rules one and two of this work. Carefully study them until you under-

stand them *thoroughly,* as reference will be made to these rules throughout the work.

The axillary vein is the best to use in removing blood, and the axillary artery, which is found immediately accompanying the vein is the most superficial of the large trunk arteries and one of the most satisfactory arteries for the embalmer to use.

After the heart fails to perform its function and death occurs, the muscular action of the arteries and capillaries continues until a large percentage of the blood contained in them during life is passed through the capillaries and enters the venous circulation, some blood, by the law of gravitation, remaining in the capillaries of the dependent parts of the body, causing the post mortem discoloration found in such parts of almost every dead body.

When this discoloration exists, it is proof positive that the venous circulation, which is capable of distention, is abnormally distended with the blood of the body that before death was contained in the arteries, capillaries, and veins. The blood of the body gives embalmers the greatest trouble, as it is most susceptible to decomposition and causes post mortem staining and puffing of the tissue; in fact, all the trouble experienced by us has been caused by the blood we left in the bodies we have embalmed. This would not have occurred had we removed enough blood to give us a life-like color of the body, and used fluid enough to disinfect the tissue of the entire body, and in addition to this, had disinfected with our fluid the blood we had allowed to remain in the body, by using enough fluid to permeate thoroughly the capillaries, mixing, as it must, with the blood remaining in the capillaries and veins, in this way causing a thorough disinfection of both tissue and blood.

That this has occurred we have just as positive signs to

guide us as the medical doctor has conclusive symptoms to guide him in diagnosing different diseases.

The signs that should guide us in our work are:

1st. A dryness of the skin.

2d. A mottled condition appearing. (This will surely appear if we use sufficient embalming fluid containing *any* astringent properties,) When an old line fluid is used, these most conclusive signs do not appear, and the embalmer is, in consequence, more or less in doubt.

3d. A firmness of all parts of the body.

4th. A proper life-like color, produced by liberating some of the blood from the body, at all times through a vein, preferably the axillary, and a gradual lighter color of the blood, proving positively that fluid had passed through the capillaries and was escaping (both blood and fluid), through the vein.

I advise using the Genung-Eckels draining tube, inserting it into the axillary vein; as this vein is more superficial than any other equally large vein, it is always found quite near the surface and can be raised without disturbing an artery or nerve.

This vein can always be used for the purpose, and by using it, any discoloration of the face, neck and hands (the parts of the body, by the way, which are exposed to view on the day of the funeral) may be removed that can be removed in *any other* manner. Even in cases where there is a great amount of fibrin contained in the blood, enough of the liquid or serous part of the blood will filter out through the draining tube to give us this result, even though all the fibrin does not pass out. There are no valves in the arteries, therefore an injection in any one of the arteries will carry fluid to all others (in normal cases this will occur).

The most uniform and equal distribution of fluid is se-

HOLDING THE VEIN OPEN WITH VEIN FORCEPS PREPARATORY TO INSERTING THE GENUNG-ECKELS DRAINING TUBE.

cured when we inject the embalming fluid directly into the aorta. This can be accomplished easily by raising the axillary, iliac, or femoral artery, and inserting a flexible silken catheter of sufficient length to enter the aorta. By injecting the fluid through such catheter, it is started on its way at the same point in the systemic circulation, that the blood circulation starts from the heart in life, and the circulation of the fluid will be as general and complete, as is the blood circulation. This should always be done, for the following reasons:

1st. There is never so quick an escape of the fluid with the blood out through the axillary vein if one of these arteries is injected in this manner, as there often is in using the brachial artery for injection, and the accompanying vein to allow blood to pass out.

2d. Often when injecting through the radial, brachial, axillary, or carotid arteries, using a short artery tube, the signs of dryness, firmness, and the mottled condition appear first nearest the point we are injecting, and oftentimes spread and become so marked as to cause us to stop injecting fluid, even though no signs of any fluid having entered the lower limbs or lower part of trunk of body have appeared. To continue injecting fluid until they appear on the limbs and trunk has often given, and often will give, undesirable-looking hands, neck or face (usually on one side.) We must stop the work of injecting fluid before we produce this objectionable result, even though the lower part of the body has not been properly disinfected, as we have been, and in future will be, called upon to show the hands, neck, and face on the day of the funeral.

By injecting through the axillary, femoral, or iliac artery, using the long silken artery tube, such unpleasant results will not follow.

## INJECTION BY GRAVITATION.

I belive in all fluid being injected by gravitation, one to four feet elevation being enough to inject in any case of arterial embalming, at the rate of one quart in ten minutes. Faster than that may cause putty-colored or any other colored spots that are never caused by slow injection. The amount of fluid necessary to produce the four signs given will vary from one quart to every twenty pounds, to one quart to every fifty pounds of the weight of the body, according to the condition of the case. A slender body, dead a number of days, may need more than one quart to every twenty pounds of weight; a fat body, or one injected shortly after death, may show all the above signs before one quart to even fifty pounds has been injected.

Having tried all methods of embalming that I have ever been instructed in by the bright men who have given their talents and time to instruct us and all the methods I have read of during the last few years, I have practiced almost entirely the work as described, viz.: passing blood out of the axillary vein and injecting through the axillary, femoral, or iliac artery, and believe it to be the method that gives the best results.

It seems nature intended us to use this vein, as the axillary region is the only one (I know of) where we come upon the vein first. Some men for certain reasons maintain that the iliac vein is just as good for drawing the blood. My experiences in using it have disproved this to my entire satisfaction, as in many cases, I have had swollen jugular veins, with discoloration remaining in hands, face and neck, even though blood (or blood and fluid) passed out, producing a thoroughly disinfected body, but upon examination of these

bodies, I have found that large quantities of fibrin had filled the entire space of the right auricle of the heart and would not allow the blood which caused the discoloration of hands, face or neck to pass through and out of the inferior vena cava.

I admit that a like filling of the right auricle of the heart with fibrin may occur if blood is drawn from the axillary vein, but it will do no harm; and this method will always clear the hands, face and neck of discoloration caused by blood there. Even though all discoloration from the same cause should not pass away from the legs or trunk of the body, it is no reason for worry, as enough fluid may in every case be used to disinfect thoroughly all blood remaining, and it will do so by the time the four signs referred to in Rule one appear.

The artery of the arm or leg should always be injected towards the extremity. This should not occupy more than from three to five minutes. It will prevent any possibility of odor or trouble. Upwards of six ounces of fluid will be needed to properly care for an arm, and an additional amount in proportion to its size, for the leg.

The bodies embalmed by this method show better results than by any other. The hollow needle should not be used either to remove gases or liquid secretions from the cavities or to inject fluid in any cavity until upwards of ten hours after the first injection, knowing that we could give a second injection in case it were necessary; that is, in case any part of the body should at that time remain sott and need more fluid, it then could be treated, as the systemic circulation would not have been ruptured and parts of a body will receive fluid at a second arterial injection that had not received any at a first.

After about ten hours, in bad cases of cystic tumor, dropsy

or secretions in the cavities, remove the cause of the trouble by aspirating and injecting some fluid in such cavities.

Reasons for not using the hollow needle when the body is first embalmed are these:

1st. No person can tell what injury he may do to the systemic circulation by its use; if he does not use it, he is sure that he has not caused any injury to it.

2nd. The circulation of blood in life keeps the tissues and all organs normal and in good order. Why should not this same circulation after death be established, using pure fluid in place of the blood, in this way driving out the blood, which will decompose quickly after death, and filling all spaces occupied by blood in life, (or nearly all,) with a positively good disinfecting fluid, which, in ninety nine out of every one hundred cases will prevent any later trouble, and this without any attention whatever to the cavities of the body or the contents of these cavities.

To those who may criticise such work I ask, try it a few times, following this line of work, as advised, or until the signs I speak of appear up to or upon the neck. Do not continue injecting until you mottle the face. Stop when a firmness appears in the ears and a dryness comes over the entire body. Leave the case then and allow the gas "of any good formaldehyde fluid" to affect the face during the next ten hours. It will do it every time, *provided,* you have not made a countless number of holes in the systemic circulation by using the hollow needle. If you have, said formaldehyde gases will follow the course of the least resistance and pass into some cavity through the perforation you have made; whereas, if the circulation has not been disturbed, they must, as they form, pass to the only unoccupied space, viz.:—the arteries, capillaries and veins of the head. "Try it before you condemn it."

A body so embalmed will improve every day. If it is not purging when these four signs appear it will not later. It may be kept in a warm room at any time of the year. The funeral can be arranged for *any* later day, up to one week, without any fear, or any further work. Can as much be said of bodies embalmed where a hollow needle is used? Certainly not. As there may be much adverse criticism on this manner of work, I shall try to answer some critics now.

First question. "Why use four to eight quarts of fluid when a body can be embalmed with three quarts?"

Answer. Anybody can do that, but no living man can thoroughly embalm or disinfect a body, and be absolutely sure that it will remain in a first-class condition two or more days, unless he use as much fluid as suggested. Partial embalming may be done with one pint of fluid to each one hundred pounds of flesh. Thorough embalming cannot.

Second question. "Why occupy from one to two hours, when a body can be embalmed in thirty minutes?"

Answer. Same as before. Anyone can partially embalm a body in that time. Thorough and good embalming should take from one to three hours.

Third question. "My patrons won't let me work over their dead more than thirty minutes."

Answer. If you draw blood by using the hollow needle, your patrons wouldn't let you work over their dead thirty seconds, if they saw you do it. Try inviting them to remain and see you embalm their dead in a neat, scientific manner, and possibly you will be surprised to learn how interested they will become, and how they, the patrons, doctors, nurses and others, will compliment you on your manner of work. You will hear such compliments about this method of work, and you are safe in allowing any who desire to remain or enter the room during the work. I cannot remember re-

ceiving one compliment on my "skill" as an embalmer from anyone who, years ago, watched me perform the operation of drawing blood with the hollow needle by puncturing the heart or vena cava.

HOW TO INSERT DRAINING TUBES.

In accomplishing the results as described above by the use of the Genung-Eckels draining tube it is essential that this instrument be inserted in the axillary vein, (high up in the arm pit), passed through the subclavian, opening or passing through the valves of the axillary and subclavian veins, and also passing through and beyond the valve located in the subclavian vein outside the point at which the jugular vein unites with the subclavian vein and forms or empties into the innominate vein. These valves, being the only ones in the veins between the point of opening of the axillary vein and the right auricle of the heart, the venous blood of the body should pass out, or be forced out by the injection of fluid into the arteries, thereby causing a pressure through the capillaries and forcing all blood from all parts of the body to the right auricle of the heart, in the same manner as this blood flowed in life; and, as there is this unobstructed passage, the blood should flow freely out of this tube. It will do so through the Genung-Eckels tube better than through any other tube for the reasons already given. In using this or any other tube the operator should use common sense and good judgment. To avoid the liability of soil to clothing, board or couch, or to the carpet, he should always carry with him a piece of rubber cloth, say two to three feet wide and four to six feet long. Place the end of this under the body or between the body and board, couch or bed. The end of the rubber cloth on the floor is a desirable place for soiled instruments, soiled cotton or cloths. It is an easy, simple matter to cut all clothing, if necessary, at the back

of the neck, and this will allow all to slip over the shoulder, off the arm, and all such clothing can be placed over chest and need never be soiled if this precaution is taken. Always place the arm at right angles with the body, palm of the hand toward the feet. Make incision and raise axillary vein. Ligate same at the lower end of the opening. This will prevent blood from the arm escaping and creating any soil. Place ligature around the vein at the upper end, from one to one and one-half inches above the lower ligature. Merely place this under the vein; do not tie it until the draining tube is inserted the desired distance. By raising gently on the ends of this ligature any escape of blood will be prevented. Make an incision in the vein, half severing it, just above the lower ligature. Introduce the ends of two pair locking (spider) forceps. Cut the vein lengthwise through one side between the jaws of the forceps. The vein can be held better by using the forceps. Select the size of draining tube needed for the vein. Place the plunger or cleaner inside it and insert in the opening in the vein. Relieve the tension on the upper ligature around the vein and continue to insert the tube. Should an apparent obstruction be found, change the position of the arm a little and move the end of the tube upward, downward, to right or to left, when it should always enter the vein easily; always insert drainage tube until the end has passed the valve near the jugular vein. Never use force enough to rupture the vein. In case the vein is bifurcated into several small veins, or serious obstructions should prevent its introduction, remove the tube, ligate the vein, sew up the incision, and repeat the work in the other arm; as bifurcations rarely occur the same in both arms. This will not be necessary, however, one in one thousand times. Often when the vein is first exposed, it looks very small. Do not be discouraged: proceed as di-

rected, and after the forceps are in place and the vein opened a little, lengthwise, you will always find it much larger than you at first supposed it to be. After the tube is inserted, ligate it firmly, using a surgeon's knot at all times, leave the ligature long enough to tie the ends around the post at outer end of the draining tube. This will prevent its being drawn out of the vein while the blood is draining. Remove all objectionable discoloration possible, by manipulation, (before injecting any fluid.) Massage carefully all exposed parts of the body where discoloration appears. Wet the face, neck, and hands, using water on your hands, or better still, a damp, soft bath sponge, carefully stroking face and neck downward over the line of the jugular vein. This should always increase the flow of blood. Be sure, by inserting the cleaner, that the tube is not stopped by clotted blood and that the rubber blood tube is open and free of obstruction. You should never under any circumstances use an aspirator on the draining tube. Let the blood flow out if it will. If not, force it out by pressure of fluid through the arteries and capillaries. I realize that there are as many different manners of embalming dead bodies for funeral purposes as there are different kinds of embalmers, or rather, different classes of embalmers. We ocasionally meet a man who thinks that a goodly quantity of fluid should be used to thoroughly disinfect a body. We meet others who think that four quarts of fluid is a goodly quantity to use in any dead body. Others whom we talk with reduce the quantity to three quarts, and so on down, until we find some who insist that they can embalm a body with one pint of fluid. There are mercenary reasons for embalming the dead in a thoroughly good manner, in addition to the natural desire to produce good results, as this is the best means of advertising.

It is an admitted fact that some dead bodies will show marked signs of putrefaction within ten hours, and others not until after a number of days. Could we always tell the latter, we need not inject in them any fluid, while the former we should embalm thoroughly. As you cannot positively foretell the bodies that will go to pieces quickly, you should not take any chances, but *thoroughly embalm* all. If the Genung-Eckels draining tube is used properly, and fluid of a good preserving quality injected until its presence is apparent in all parts of body, producing the four signs alluded to in Rule one, a successful preservation without any chances of failure is assured, even though you may hold such cases a number of weeks. Can so positive a result be obtained in any other way, than by a thoroughly scientific circulation of the fluid to and through all parts of the body? Following the course which we are taught the blood flows in life, we all know the normal circulation of the blood in life would be stopped if any arteries were ruptured or punctured—why should we expect less if we cause this ruptured condition to the same circulation after death by using any "hollow needle," before this complete circulation of fluid has been accomplished?

## WHY DRAW BLOOD?

The question of the advisability of drawing blood has for many years occupied the attention of all thinking men who have practiced the art of embalming. A few maintain that it is not necessary; others, that it should always be done. The most pronounced failures known in the past few years have occurred where bodies have been embalmed and no blood withdrawn. The best and safest way is always to be ready to drain blood should occasion arise. The Genung-Eckels Draining tube can be inserted into the axillary vein, withdrawn and the vein ligated, in less than three minutes

by an expert embalmer. By placing a rubber tube of convenient length, fitted with cutoff, on to the draining tube, blood can be allowed to pass out of the body in the most scientific, as well as the most practical manner, at any time the embalmer should deem it advisable. Should the first three signs mentioned in Rule one appear, and the color of the body be life-like, the embalmer need not allow any blood to escape. It would be better, however, in such a case, to allow all blood that would, to pass out at this time, and inject some fluid into the venous circulation, as an additional guarantee that the blood left in the body is more thoroughly disinfected. In all sudden deaths this method is the safest to employ. In bodies dead of uraemia, the venous system, the capillaries, and the arterial system are often found nearly full. It would be utterly impossible to inject enough fluid into such a body to disinfect it without removing some blood, even though the condition of the case at the first examination should not indicate the necessity of removing any blood. In such a case, an injection of only one pint of fluid would show a distension of the temporal and jugular veins, often given as an evidence of proper embalming. Should such conditions arise, merely open valve in cutoff and allow blood to be forced out of arteries, capillaries and venous system, through the draining tube in the vein, regarding the work as complete and perfect only when the four signs given in Rule one, appear. Under no consideration should you aspirate when using a vein tube. Such an act would surely collapse the flexible vein around the openings in the vein tube and prevent its allowing the blood to flow out. It is better to force the blood out by the pressure of fluid through the arteries and capillaries upon the blood in the veins of the body. Such pressure must cause the blood, or blood and fluid, to flow to the "well" of the

body, the inferior vena cava, the right auricle of the heart, superior vena cava, right and left innominate veins, and thence out of the draining tube.

There is often a small quantity of blood in the arteries, but not enough to cause flushing of the face by using any artery for injection when blood is allowed to pass out through the draining tube. Even when using the femoral or iliac artery, injecting toward the face, this flushing will not occur providing you follow Rule one, and inject not faster than one quart in ten minutes.

We must admit that some fluid may pass out with the blood, but the fluid loss is so small compared with the good results obtained, that any embalmer can well afford this loss.

Good embalmers drain blood in this scientific manner from a vein of the body, so as to be able to ligate the opening made in the venous system. For many years the only available instrument was the flexible silk catheter with an opening in the end. With this instrument success could be obtained in cases where very little fibrin was present in the blood, but this instrument proved nearly worthless where much fibrin was present. Later the spiral draining tube, long enough to enter the femoral or basilic vein, and reach the right auricle of the heart, was used. At times this could be done successfully, and at other times it could not. On account of this trouble, they have in the last few years been made of various lesser lengths, but there still remain hindrances to their being used with marked success by the average practicing embalmer. They are easily broken and wear out in use or by cleaning; frequently they cannot be withdrawn from the vein after the body has been embalmed, but must be buried with it. Their introduction is always accompanied by a greater or less escape of blood, causing soil.

The Genung-Eckels draining tube is offered to the embalmer as an instrument that does not possess any of the above faults. It can be introduced easily at all times, and should never wear out. It will drain as much, if not more blood than any other instrument, and should it become clogged, may be opened the full diameter of the aperture without withdrawing it from the vein. It can be introduced through the iliac vein and drain the blood from the body as well as any other instrument, although the inventors do not recommend the use of this vein for the purpose, preferring to use the axillary vein for the reasons given elsewhere.

### INJURY TO THE CIRCULATION DONE BY USING THE HOLLOW NEEDLE.

I cannot imagine a case where the hollow needle should be used before we have thoroughly embalmed the body. It may possibly be used and not destroy the proper circulation of the fluid; still it would be better first to obtain that circulation. Then we are positively sure we have not destroyed it.

Scientific as well as practical embalmers of the present day who have used the cardiac needle, hollow needle, or trocar (call it by whatever name you may) to draw blood from the right auricle of the heart or the superior vena cava, and have afterwards traced to its use the injury done to the vascular system, will agree that no one can be sure that he has not caused an injury to the circulation. These blood vessels are out of sight of the operator, and are so thin and delicate of construction that the act of puncturing them by any sharp-pointed instrument could not be noticed by the sense of feeling in the hand of the operator at the other end of the instrument. Ninety-nine times out of

every one hundred an injury to the arterial circulation will be found should you take the trouble to open the body and follow the track of the hollow needle.

Having examined many such cases, even after some expert embalmers had inserted the hollow needle, I have seldom found a case where the expert had accomplished the puncturing of the venous circulation as he thought. In nearly every case, the arterial circulation had been ruptured by the hollow needle. In each of these latter cases, embalming fluid injected through an arterial tube having an opening less than one-eighth of an inch in diameter, would find a ready escape out of the opening, say one-quarter of an inch in diameter, which was made by the hollow needle, and the entire amount of fluid usually injected could be contained in the thoracic cavities, and great quantities of this fluid, mixing with a small quantity of the blood of the body may be aspirated, and often considered by the operator to be venous blood. Should the embalmer puncture the venous circulation only, he has done an irreparable injury, as he is unable to close the opening or puncture at this or a later time. Granting he had produced a life-like looking body by his embalming, the life-like color of the face being produced by the blood and fluid filling the capillaries, this blood and fluid, by the law of gravitation, would settle through the veins away from the face, leaving it pallid or of a lighter color, to a lower point, and escape into the cavities around the heart, through the openings made by the hollow needle. On the other hand, when the same life-like condition is produced by following the method advised in Rule one, the incision made in the axillary vein, being ligated when the draining tube is removed, leaves the circulation intact and complete, as before operation, and no change whatever can occur. Moreover, at any later time, fluid may be injected

into the systemic circulation as successfully as it was at the first injection, without causing any escape; whereas, if any opening before made by any hollow needle existed, it always remains an open door and ready means of escape from the systemic circulation of any fluid at a later injection.

### CHEMICAL ACTION OF EMBALMING FLUIDS.

Some claim that certain fluids by the "chemical action" cause a life-like appearance even when great discoloration exists. This abnormal color is caused by the blood remaining in the capillaries and will always disappear when this blood is removed either by manipulation, by massage, or by forcing it out of the capillaries into the veins by pressure of any fluid, without regard to its "chemical action."

Tests to substantiate my claims are easily made. Try the following test on the first body you embalm. Raise both iliac or femoral arteries and inject one leg downward with a quantity of such "magic acting fluids," and then inject the other leg downward with a like amount of any good disinfectant fluid. You will find just as much "magical chemical action" in one leg as you do in the other, as in each case you will drive out the blood contained in the capillaries by forcing it into the veins of the body, and as the same occurs in each leg, the results are likely to be the same. Water will do as well and perform as great a "chemical action" as any embalming fluid, but it would be a poor fluid to disinfect the tissue.

### THOROUGH DISINFECTION OF THE DEAD BODY, TO PRESERVE IT FOR AN INDEFINITE PERIOD.

Thorough disinfection of the body can only be obtained by injecting enough fluid to permeate all or nearly all tissues of said body. In such cases, use the draining tube, as

THE GENUNG-ECKELS DRAINING TUBE ENTERED INTO THE AXILLARY VEIN.

the surest way to obtain this result, without any regard to the condition of the organs of the body or the contents of the cavities. Proceed to embalm the body as directed in Rule one, and by proceeding further as described in Rule two, proper care and disinfection of the cavities of the body can be secured, without the use of any hollow needle, and all foreign matter and gases may be removed without any puncture being made through the walls into the cavities, which is likely to cause trouble. Employ this method in cases of long-time preservation, for the following reasons: By leaving the arterial tube in the body, you can inject as much fluid as you desire at a second or third injection on subsequent days. Be sure, in all long-time preservation cases, to remove enough blood. It is best to remove all the blood possible before injecting any fluid. Great quantities of blood may be forced out by changing the position of the body and by constant application of pressure or manipulation. If you do this after you start the injection of the fluid, and the color of the blood passing out becomes lighter, you may think the blood so passed out is part fluid. If done before any fluid is injected, you are *sure* it is all blood and secretions of the diseased body.

Good judgment, however, should be used with the care of this body in after days, weeks, or months. I firmly believe that the Egyptian mummies were produced chiefly because the soil and climate favored desiccation. The lack of humidity was the chief reason that the bacteria of putrefaction did not form; so should we be sure that our bodies, after being thoroughly disinfected, should not be subjected to great humidity, but rather, that they should be kept in a dry room where the temperature is at all times above freezing, as humidity will surely produce mould, even on the best preserved or embalmed dead tissues. As a preventive against

this condition, I would suggest that all such cases be protected in the following manner: Coat the face, neck, hands and wrists with a heavy coating of vaseline from one-eighth to one-half inch in thickness. Cover the entire form, including the clothing, with pieces of lintine or absorbent cotton before placing such body in any receiving vault. Later this coating of vaseline may be removed (by using ether, grain or wood alcohol) and the condition of the tissues be found in each and every case without any change, other than the change of desiccation.

Concerning this change, I would say that it may occur on bodies at varying times, within three days after death, or not until after months. While this mould formation may not be an indication of decomposition, it surely is very unpleasant, and can be avoided by following the above instructions.

### TREATMENT OF DROPSY CASES.

Some still maintain that it is necessary to leach the limbs, and in that way remove the liquid secretions from the tissue in dropsy cases.

If you use an embalming fluid that does not contain formaldehyde, I would advise the same method of work, as without formadehyde, you could not harden the liquid secretions and would be obliged to let it drip out. It would, anyway, whether you leached the limbs or not. Blisters would form now, just as they did years ago, if we used the same kind of fluid we did then. That is why we use formaldehyde fluids now to care for such cases, and it is why we do not have the blisters and other troubles.

We may by the use of rubber bandages drive the liquid secretions from the tissues of the limbs into the vascular system, and such liquid secretions will pass out through the

draining tube in the axillary vein. For a long time I have practiced and demonstrated this work, and after considerable investigation of this subject, and consulting some of the best students of physiology in the United States, I am convinced that the result we produce by this pressure is to force the dropsical fluid from the tissues themselves into the lymphatics, and that it, together with the fluid already in the lymphatics, is forced up through the internal and external superficial and deep lymphatics of the leg. These communicate with the lymphatics in the pelvis and abdomen and unite with the thoracic duct, which enters the sub-clavian vein at its angle of junction with the left internal jugular. After this fluid has passed into the sub-clavian vein, it cannot return into the thoracic duct because of the valve at the end of that duct.

The fluid forced into the sub-clavian vein by the pressure of the rubber bandage follows the course of least resistance, and passes out through the draining tube, which has been inserted through the axillary and sub-clavian veins. Should there be a right branch of the thoracic duct, as there sometimes is, it empties into the right sub-clavian vein, from thence into the right innominate vein, which joins the left innominate vein and with it forms the superior vena cava.

This lymphatic system is the sewer of the living body, carrying off all waste matter. The pressure of the Esmarch bandage drives the dropsical secretions that lie in the interstices of the connective tissue, and in these spaces is the commencement all over the body of the lymphatic system. The pressure would tend to force open the lymph radicals, and most, if not all, of this dropsical fluid would be forced up and into the venous system through the lymphatic circulation.

### CRANIAL METHOD OF EMBALMING.

The use of any cranial method of embalming the dead is so disgusting to any embalmer that none practice any of these methods more than a few times. Any one is justified in arriving at this conclusion, as in no case can any desirable results be obtained by their application that could not by a thorough arterial injection, using any of the arteries generally used by embalmers.

Surely, the application of any cranial method would be objected to by all our patrons who had a spark of sentiment or affection for their dead. Such uncalled-for mutilation of the head should not be practiced by any embalmer, under any circumstances, at any time.

## FUNDAMENTAL RULES FOR PROCEDURE WHEN EMBALMING THE DEAD.

### RULE ONE.

Insert the Genung-Eckels draining tube in the axillary vein; allow blood to pass out until the color of body is life-like or natural, injecting fluid through an artery, preferably the axillary or the iliac. When the artery is chosen, always inject toward the hand or the foot enough fluid to cause the arm or leg to become dry and firm. Then inject fluid through the same artery towards the trunk of the body, not faster than one quart in ten minutes, until the following four signs appear:

1st. The surface of the body becomes dry.

2d. The flesh becomes firm.

3d. A mottle caused by the fluid used spreads over the body.

4th. Fluid with the blood escapes through the draining tube.

Stop injecting fluid and remove the draining tube when the first three signs appear over the body up to the neck and ears, provided the color is normal. If the color is still too dark, allow blood to continue to pass out of the draining tube until the exposed parts of body are life-like in color. Then remove the draining tube and ligate vein. Leave the arterial tube in the artery directed towards the body until you can examine body, say, ten hours after first injection.

Remove artery tube directed towards the arm or leg, at the same time you remove the draining tube at completion of the first injection, ligating the artery when you remove it. After ten hours examine body. If it is dry all over the surface, and a firmness of the tissue is apparent all over the body, it will not need more fluid for a preservation of say one week. Should any parts of the body be soft and damp, inject enough fluid to cause those parts to become dry and firm. When all parts of the body are dry and firm, remove the arterial tube. Should you be called upon to hold body longer than one week, I would advise a second injection of fluid at from ten to twenty hours after the first injection.

After the entire body is dry and firm no harm could be done by using the hollow needle in any or all cavities, removing gases or any secretions from them and injecting them with fluid. It will be found unnecessary, however, in most cases.

The amount of fluid needed to produce the above four signs will vary from one quart to fifteen pounds to one quart to fifty pounds of the weight of the body, providing that a modern embalming fluid is used in all cases. If an old line arsenical fluid is used, there are no such positive signs that will assure the embalmer that thorough disinfection has been accomplished.

The embalmer should be sure the body has been washed,

and a wise precaution is to sponge the entire body with embalming fluid. Always examine and find whether there has been any discharge from the anus. A quantity of absorbent cotton dampened with embalming fluid should be forced into the rectum, which prevents any further trouble. Always close the mouth and eyes properly before embalming.

Carefully observe Rule two.

## RULE TWO.

### TREATMENT WHERE PURGING OCCURS WITHOUT THE USE OF TROCAR OR HOLLOW NEEDLE.

All purging from the lungs or from the stomach is caused by fermentation of the secretions contained therein, or from leakages of the embalming fluid into these cavities, or from the secretions and leakages of fluid in the stomach or alimentary canal, forced from thence by gases; and may be stopped by producing pressure on the cavities (the thoracic or the abdominal cavity) so as to drive the secretions, gases, or fluids into the throat, and from there they may always be aspirated into a bottle. When such purging occurs, stop the injection of fluid and aspirate through a nasal tube, (a flexible silken catheter, with opening about one-quarter of an inch in diameter, being preferable, as it can be bent into such shape that it may in all cases be inserted into the throat through the nostril,) manipulating the epiglottis by pressing it first to the right, then to the left. This will always allow the secretions and gases forced up through the alimentary canal or bronchial tubes to pass into the throat and from there may easily be aspirated into a bottle. This result is best produced by elevating the foot end of the embalming board or couch, while pressure is applied to the body as above described. By following this rule NO rupture of the systemic circulation will occur and all can be accom-

GRAVITATING FLUID INTO THE AXILLARY ARTERY IN BOTH DIRECTIONS, AND DRAINING BLOOD WITH THE GENUNG-ECKELS DRAINING TUBE.

plished by this method that could be by using the hollow needle.

With bodies purging after the four signs of Rule one appear, there is no objection (excepting in cases of long-time preservation) should the embalmer desire to use the hollow needle, as he would not aspirate the fluid from the tissues or capillaries, because the astringent properties of a formaldehyde fluid are so great that, having entered the capillaries or tissues, it could not be withdrawn.

### AUTOPSIED BODIES.

Autopsied bodies and cases in which the arterial and venous circulation have been ruptured or where such leakages occur, caused by gun-shot wounds, railroad or other accidents, should be embalmed in such manner that all parts of the tissue would receive enough fluid to disinfect it. This can be done only by injecting fluid towards the extremities of the body through the arteries which supplied these parts with blood in life. To embalm the face and head inject through the common carotid arteries. Always use both of these when caring for the head. Raise both axillary arteries and inject towards the hands. Raise both iliac or femoral arteries and inject towards the feet. Should there be an incision large enough, sponge out all secretions, blood and fluid from the cavities, and fill the cavities with a strong formaldehyde fluid. Good results will be obtained should you place numerous pieces of absorbent cotton or lintine in various parts of the cavity, before you insert the fluid. Drying compound may be used with good results, provided it is thoroughly distributed around all the organs. Sew up all incisions neatly and place a piece of lintine over all the incisions before the body is dressed.

The entire tissue of the trunk may be disinfected by using

the long hollow needle, hypodermically injecting a goodly quantity of fluid throughout all of this tissue.

Upon an autopsied body, or where there is a ruptured circulation, also with a case of venous congestion, or where tissue gases have formed, the carotid arteries are without a doubt the best to use in treating the face, as they only could carry fluid directly to the face. When the above conditions do not exist, they are no better than the axillary, or perhaps other arteries, for injection. Personally, I prefer the axillary, iliac or femoral arteries for injecting when following Rule one. My reasons are given in the first part of this work.

### WHEN TO PROCEED TO EMBALM DEAD BODIES AND HOW TO OBTAIN THE BEST RESULTS FOR FUNERAL PURPOSES.

Bodies dead of pulmonary disease, or any wasting disease, may show signs of putrefaction soon after death; also those dead of puerperal convulsions, peritonitis, appendicitis, Bright's disease and fever, and cases where dropsy is contributory, should be arterially embalmed as soon after death as possible, as delay may cause additional labor.

The regulations in many cities are such that considerable time must necessarily elapse after death before the embalmer can proceed to embalm the body. In most cases delay embalming from ten to twenty hours, as patrons like this delay. When you are called, especially at night, properly lay out the body and return during daylight to embalm it. Even though your eyesight is fairly good, you will have less trouble in daylight than working at night with artificial light.

### "LIFE-LIKE" COLOR.

Some embalmers pay little attention to the "natural, life-like" look of the body they embalm, and are satisfied whether

it looks very pallid or is greatly flushed, and maintain that it is easy to paint or tint any body.

The embalmer who desires to produce and retain a life-like color of the face and hands, should devote considerable time to manipulating those parts of the body before any fluid is injected. Continue this manipulation of the hands and face, if the color demands it, during the time the fluid is injected. Devote all the time necessary to produce this result. Hold the hands high above the body and carefully stroke the face, neck and hands to aid the blood to pass into the larger veins of the body, using sufficient time to obtain a good color.

Concerning the necessity of more than one injection of fluid: If using an arsenical fluid, I should advise a second arterial injection if expecting to hold the case more than forty-eight hours; if using formaldehyde fluid, it is easy to obtain the desired results by the one injection. Gravitate the fluid in all injections, always use cutoff valves on both arterial and draining tubes; with them you have perfect control of the circulation and can retain the life-like color when it is obtained and know that it will remain so, after ligating the artery and vein, provided you have used enough good fluid.

### THOROUGH DISINFECTION OF THE DEAD BODY.

While this subject is one which many readers may not be interested in, and may assert that they are never called upon to preserve bodies for more than a few days, and feel that almost any kind of an arterial injection followed by thorough cavity work, using the hollow needle and plenty of fluid in the cavities, will give them good enough results, still it is not the best method of embalming, *and nothing but the best should be good enough.* Upon your next call you may be requested to preserve the cases many days or weeks. Then

only a thorough circulation of fluid to all parts of the body will produce this condition. The most expert embalmer cannot always tell if he has accomplished this at the time of the first injection, but any embalmer may obtain by a second or third injection, provided he has not destroyed the circulation by using the hollow needle.

### POSITION OF BODY WHILE BEING EMBALMED.

The position the body should occupy while being embalmed depends upon how well you do your work. If you desire to follow rules one and two, using three or four quarts of fluid to produce the four signs, have the body nearly level, head slightly raised, in an easy, natural position. If you desire to embalm all bodies with three quarts or less it would be best to elevate the foot end of the board so that gravitation would carry some of the fluid to the head and shoulders. Should you inject only two or three quarts arterially, having the head end of board highest, gravitation would always carry most of the fluid into the legs and lower part of the trunk of the body. It will be seen that the first position and method is far the best.

### JUGULAR AND AXILLARY VEINS.

Some hold that better results can be obtained by tapping the jugular vein than by inserting draining tube into the innominate through the axillary vein. The latter method is in reality so much neater operation that nothing is left to be said in favor of the former, while much may be truthfully said against it.

First, no marked success in removing blood by tapping the jugular vein can occur unless some tube be passed through it as far as the innominate vein, as the valves at lower end of said jugular vein prevents the blood from

passing out, and when any tube is passed to this point, it has entered and drained the blood from the venous circulation, from the same part of this venous system as does the draining tube that is entered through the axillary vein. There are four jugular veins, the deep jugular, anterior jugular, external jugular, and posterior jugular, on each side of the neck, eight veins draining blood from the neck, face and head into the innominate veins, where the Genung-Eckels draining tube is to be introduced.

Secondly, this axillary artery, even on the stoutest person is close to the surface, and in stout people (the bodies from which we most desire to draw the blood) this operation becomes one that all embalmers can perform in an easy and neat manner, while the axillary vein can be raised easily and neatly by the average practicing embalmer. In fact, any person who has practiced raising it two or three times ought never afterwards to experience any trouble in successfully raising it and drawing blood, even on the stoutest bodies, and, as the results obtained are practical and scientific there remains no good reason why we should continue to cut the head of the bodies we are embalming half off to get at the jugular vein when the same results are to be accomplished by an incision, say, one inch long and less than one inch deep (usually about one-quarter of an inch deep) in the axilla.

### IN CASES OF PARALYSIS AND APOPLEXY (CEREBRAL HEMORRHAGE.)

We have often been told that a leakage of fluid would occur and such bodies could not be successfully embalmed by the arterial method. While a leakage into the cranial cavity may occur, it is very beneficial, as it is really needed there to disinfect the blood that has escaped into the cranial

cavity and caused the death. Only a limited amount of embalming fluid escapes and the leakage stops as soon as the cranium becomes full, as fluid does not readily escape from the cranial cavity; therefore, after this occurs, the conditions will be the same as in other causes of death, and can be embalmed the same as bodies dead from any other cause.

### CASES OF DEATH FOLLOWING AN OPERATION.

Many embalmers are ready to advise quick burials in these cases, claiming if they attempt to inject them arterially the fluid would escape from the incisions the doctors have made. This is not true, and it is equivalent to an accusation that the doctors have caused the death of the patient by the hemorrhage through the leakages of the systemic circulation. Such a leakage or hemorrhage may occur for a short time when the operation is performed, but the hemorrhage soon ceases and does not exist in morbid anatomy after death following an operation.

To properly embalm bodies where uremic conditions, following acute or chronic nephritis (Bright's disease) or any toxic condition of the blood (blood poison) exists, and in cases of puerperal convulsions, the embalmer should bear in mind that the veins of the body are usually filled to their greatest capacity; also that these bodies need prompt attention. Nevertheless, all such cases can be more successfully embalmed by proceeding in a scientific manner, as described in Rules one and two, and much more easily and neatly than by proceeding in the old haphazard manner of punching the body full of holes by using a hollow needle.

In all such bodies, the blood, by the results of the disease, will be found much thinner than in deaths from other causes. In draining blood in such cases endeavor to remove all you possibly can before any fluid is injected. Aid your work by

THE GENUNG-ECKELS DRAINING TUBE, EXTENDING BEYOND THE VALVES IN THE SUBCLAVIAN VEIN.

constant and careful manipulation over the greater part of the body, holding the hands and arms well above the body, and stroke over their entire length toward the trunk. Do the same with each leg. Change the position of the board or couch, first having the head end higher than the foot end; then raise the foot end, using a chair under each of the legs at the foot end, allowing the body to remain in this position as long as the flow of blood continues. Even though this act should slightly distend the jugular veins, this need cause no alarm, as all such distensions will subside very quickly, when the foot end of the board or couch is lowered again. After all of the blood that will escape has been removed in this manner, the embalmer should proceed as directed in Rules one and two.

This method will be successful in all uremia cases. The appearance of the four signs given is a positive guarantee of a successfully disinfected body. The embalmer may return to his home and go to sleep, as he will not be obliged to watch the body or worry about it. Should occasion arise that the funeral services be delayed a week or so, he need have no anxiety. Merely make a second visit at any later time, and allow more fluid to gravitate into the systemic circulation, just as it did at the first injection. It will be impossible to over-embalm the body at the second injection by gravitating the fluid, using an elevation of not over four feet, as the capillaries all over the body, that had received fluid at the first injection, will have become so astringed by this time that they will receive very little, if any, at this, the second injection. Should, however, any part or parts of the body, capillaries, tissue, arteries or veins have failed to receive the proper amount of fluid at the first injection, such parts may be so supplied at this second injection. This will be an additional guarantee of thorough permeation of all

parts of the body by embalming fluid, that had been occupied by blood in life. This positive result could not have been obtained at this second injection had the operator used the hollow needle in any manner at the time of the first injection.

We are told that the hollow needle is a good instrument to carry. So it is. Carry one with you, but never use it until you have caused to appear by the arterial injection the four signs of Rule one, even though you are compelled to resort to the method described in Rule two. It will pay you every time, by saving you much doubt and worry. It may cost you the price of a quart, or even two quarts, more of fluid than you have depended on to take care of bodies. If you have been in the habit of using two to four quarts in the arteries, and say, two quarts in the cavities, just try this method, and use the entire four to six quarts in the arteries, and let this arterial injection, by producing the four signs, take care of the cavities. "Remember the wise man is ever ready to be convinced and when convinced, to change his mind; the fool never."

Place a tape around the abdomen after following the directions of Rules one and two, and record the measure. I predict that the case will not measure as much at any later time. Try it before you condemn it. Should you embalm three or four bodies as advised in these two rules, the writer believes that you will not use the hollow needle again in one case out of forty, during the remaining years of your life as an embalmer.

## TREATMENT OF SPECIAL CASES.

### TO EMBALM A BODY DEAD FROM TUBERCULOSIS.

Proceed as directed in Rule one. Should fluid escape from the mouth or from the nostrils before the signs appear, proceed as directed in Rule two, carefully comparing the

amount aspirated with the amount injected each ten minutes. You will be justified in continuing the injection of fluid so long as the amount injected is in excess of the amount aspirated until the signs do appear. If the amount of fluid aspirated equals the amount injected, it would signify that the leakage is so great, that it would prevent any further appearance of the signs of disinfection. In such a case, inject all parts of the body that have not become dry and firm by raising and injecting the arteries that will carry fluid directly to such parts. The right and left common carotids, to care for the head; the right and left axillaries, to care for the arms and hands. After this has been done, the shoulders and upper part of trunk may be injected with the hollow needle, forcing large quantities of fluid directly into the tissues of these parts. Gently massage the parts until the fluid has been distributed throughout all the tissues of those parts. Inject all the fluid possible into the throat and allow it to settle into the alimentary canal and into the bronchial tubes to the lungs. This is a good way to do "cavity work" in such cases, and will be all the treatment needed.

However, if you prefer, use the hollow needle, and treat the cavities.

PERITONITIS, OR APPENDICITIS (BEFORE OR AFTER OPERATION.)

Proceed as directed in Rule one, and should the body purge, apply methods as directed in Rule two. As the seat of the trouble is in the abdominal cavity, this may be thoroughly aspirated by using the hollow needle, and a good, strong fluid distributed throughout this cavity as an additional precaution, should you deem it necessary; never, in any case, until the four signs of Rule one appear.

### HOW TO EMBALM A CASE DEAD FROM PNEUMONIA.

Proceed as directed in Rule one.

A large percentage of cases dead from this disease are from heart failure following the pneumonia, and will need no other treatment, as they are normal cases.

Should purging commence before the four signs appear, proceed as directed in Rule two.

### TO EMBALM BODIES DEAD OF SUNSTROKE OR HEAT CASES.

Proceed as directed in Rule one. In case the body should purge before the signs appear, proceed as directed in Rule two.

### TO EMBALM A BODY DEAD FROM HEMORRHAGE.

Proceed as directed in Rule one. Should a leakage occur that causes the body to purge, proceed as directed in consumptive cases. Ofttimes the astringent properties of the fluid will, in a short time, so close or astringe the small arteries, veins or capillaries, the rupture of which has caused the hemorrhage as to allow all the signs of Rule one to appear. If a leakage of fluid into the cavities where the hemorrhage existed has occurred, such fluid is always beneficial, as it is needed to disinfect the blood that has escaped by hemorrhage into these cavities. In case any part or parts of the body fail to become dry and firm, proceed as in case of a consumptive; that is, raise and inject fluid through all arterteries necessary to carry fluid to the extremities of the body, until such parts become firm and dry.

### TO EMBALM A BODY DEAD FROM CHILDBIRTH.

To absorb any leakage, see that plenty of absorbent cotton or lintine is placed and bandaged against the vagina. This may be removed at any time should it become soiled. Pro-

ceed to embalm the case as directed in Rule one. Should the case purge from the mouth or nostrils, proceed as directed in Rule two. At the same time, create a pressure on the abdomen, which will displace gases or secretions from the stomach and drive them to the throat, and from there they may be aspirated. In case the child is unborn, it, together with the placenta, contained in the uterus (womb) may be thoroughly disinfected by aspirating from the abdominal and pelvic cavities, through the hollow needle, all gases and blood possible, and thoroughly injecting these cavities with a strong fluid. This need not be done until after the arterial injection has been done, as described in Rules one and two.

### CANCER, SARCOMA AND GANGRENE CASES.

Proceed in all such cases as with any other dead body, following Rule one, until the diseased parts are thoroughly disinfected. A leakage may occur for a few minutes, but this will all stop in a short time. Place lintine or cotton saturated with fluid over the diseased parts and continue the injection slowly. Good embalming fluid is an astringent and will close in a very short time all small ruptured arteries or veins and capillaries causing the leakage. In all cases use enough fluid to produce a firmness of the tissue. Do not economize with your fluid.

### HOW TO EMBALM A DEAD BODY WHERE DROPSY SECRETIONS EXIST.

Dropsy is not strictly a disease, but is produced by and is contributory to any disease that has caused an obstruction to the proper or normal circulation of the blood. Such bodies should be treated in different manners, as follows:

1st. Pericarditis is dropsy of the heart sack. In these cases, proceed as in Rule one. After ten or more hours,

when all parts of body are found dry and firm, should the embalmer desire, he may introduce the hollow needle and remove by aspirating the dropsy secretions in the heart sack and inject a reasonable quantity of embalming fluid especially prepared to be used in caring for dropsy cases.

If necessary, make a second injection in the arteries ten or more hours after the first injection, always before using the hollow needle. Let this rule apply to all cases from this or any other cause of death.

2nd. Ascites is dropsy in the abdominal cavity. Proceed as directed in Rule one. Should the body purge, follow the directions in Rule two. This purging matter is never the dropsy secretions from the abdominal cavity, but is the contents of the bronchi or the alimentary canal. After the four signs appear, lower the foot end of the board or couch to the floor, and allow the body to remain in this position until a second examination, ten to twenty hours later. Should any parts of the body be found soft and damp, inject at this time, through the arteries, enough strong fluid to cause all of the tissue to become dry and firm. Then or at a later time aspirate the secretions from the abdominal cavity, using the hollow needle (as no harm can be done by its use at this time). Inject a small quantity of strong fluid into this cavity, distributing it throughout all the parts.

3rd. Edema is local dropsy and may be of lung tissue or any serous cavity or in any connective tissue spaces.

Embalm such cases as directed in Rule one, applying Rule two, if occasion requires.

Afterwards treat the cavity affected, by direct aspiration and injection.

4th. Pleurisy with effusion is dropsy in the pleural sack and should not be confounded with edema of the lungs or pneumonia.

While pressure as described in Rule two would drive the secretions of edema and pneumonia into the throat, it would not release the secretions in cases of pleurisy with effusion. Such secretions could only be removed by direct aspirating, using the hollow needle and puncturing the pleural sack. This use of the hollow needle may always be delayed until at a second examination of the body, say ten hours after the first injection, or when the conditions of the body show a second arterial injection to be unnecessary.

5th. Anasarca is general dropsy. Proceed as in Rule one. It is wise, however, to pass all blood, or blood and dropsy secretions possible, from the body via the venous and lymphatic systems, out through the draining tube, before any fluid is injected. You will aid greatly in accomplishing this if you manipulate the parts of the body that contain the greatest amount of liquid secretion, changing the position of arms and legs, at times holding them high in the air. Elevate the foot end of the board, applying Esmarch bandage, commencing at the feet and firmly wrapping the legs up to the trunk. The pressure of this bandage will in a very short time drive great quantities of the dropsical secretion into the lymphatic or venous system, or both, and it will escape through the draining tube, thus reducing the size of the parts distended (this may be done even though the skin of the arms or legs had burst before death) and make a space to be occupied by the fluid you may inject afterwards. Continue the manipulation as the fluid is being injected, removing Esmarch bandages before concluding the injection of fluid. The results as described by the four signs of Rule one may be obtained in all such cases, and any dropsical limbs be made hard and dry; provided, always, you use a strong dropsical fluid, one especially compounded to be used in embalming such cases. Do not hope for such results if you use

a fluid that does not contain formaldehyde, or some yet to be discovered chemical that will care for liquid secretion equally as well as does formaldehyde.

## CHILDREN.

In the case of those under six months old, cavity embalming will be sufficient, as burial usually occurs soon after death. For cases six months of age or older, there is no reason why they should not be embalmed in the same manner and just as successfully as adults.

The carotid arteries are large enough to raise and inject in a fully developed child at time of birth, even though the other arteries are very small.

## FUNERAL ETIQUETTE.

The subject of funeral etiquette covers a field so broad and is one in which so widely different customs prevail, in various parts of the country, that the subject cannot be treated in a manner that would be applicable to all sections. However, there are certain things connected with the management of a funeral that should be understood and receive much attention from all who claim to be undertakers and funeral directors. At the present time, the progressive, intelligent undertaker is considered, by the average patron, the one who has charge of all the funeral arrangements; and as such it is a duty he owes his patron that he devote time enough and study the arrangements well enough to become master of the situation. He should be director of the funeral in fact as well as in name, and as such, should be held responsible that every detail pertaining to the funeral passes off in a quiet, orderly manner, and should be willing to assume all responsibility for its being so, including the preparation that would guarantee a perfectly disinfected and

life-like looking body, furnishing a suitable casket and funeral furniture, all in keeping with the house furnishings, and should be the adviser on all questions apt to arise. As the funeral is constantly approaching nearer and still nearer a "social function", the duties of an up-to-date funeral director are becoming more varied; in fact, we are now expected to direct all arrangements from the time of death until the burial has occurred, including the care of the body, announcement of death, notices and invitations to funeral, engaging clergyman, singers, bearers, ushers, carriages, flowers and opening of grave or vault. That all of the above things are furnished and proper attention given to all details showing to all that there is a "funeral director" in charge of the funeral, and that the "funeral has not run itself," is the demand of our patrons, and we owe to those patrons all of the above, when we engage ourselves to them as their funeral director. The undertaker, however, should not make himself unduly conspicuous at funerals; in fact, he should be just as little in evidence as possible, yet all arrangements should be closely studied by him, even though it should take many hours of his time prior to the funeral. Whether it be a large public one or the average home funeral, the funeral director in charge should have all arrangements so well planned, and his assistants so thoroughly instructed as to their several duties, that it will not be necessary for him to give any orders or be much in evidence at that time.

While in many places the custom of closing the casket before the arrival of friends and neighbors the day of the funeral services still prevails, I do not consider it a compliment to the *deceased,* the *family* or the *undertaker.* Some undertakers like this custom, as it is always *their protection* in case the body does not look as well as they would like to

have it. With a properly embalmed body, I can see no reasonable objection to the casket being placed in such location that any who are received by the undertaker or his assistants, either friends or relatives, may view the dead, if they desire, before they are given seats. It is preferable to close the casket before the services.

It is convenient in most cases to place the clergyman in such a position that the entrance of late arrivals will not disturb him and he will appreciate it. I deem it "tact" to endeavor to please the minister. He can do you many kindnesses, and possibly direct some calls to you. On the contrary, he can make things very unpleasant for you, if he so wishes, and you cannot safely talk back to "one of the cloth." So be sure to make him your friend.

Concerning the charge of the funeral at the home, it is much better that the complete list of the relatives should be in your hands, so that you are familiar with the names prior to their arrival at the home, and that the position of these relatives, the carriages they are to occupy, should be quietly told them prior to the service. After the clergyman has finished the service, the undertaker and his assistants, having carried the casket to the bearers, they being previously stationed on the outside, and after the assistants place the casket in the hearse, the director has merely to inform the immediate relatives that the carriages are in waiting. It is not possible to give this attention in all cases, and in such instances the carriage list must necessarily be called. However, the former way is far better.

Concerning the handling of the funeral cortege at the cemetery, it is much better that the carriages pass the plot, and that the relatives and friends leave them there. The services should not begin until all carriages have passed away, nor are any coaches allowed to approach near enough to

disturb any part of the burial service. The carriages are then brought up in the same order and leave the cemetery before anything whatever is done at the grave. While maintaining that the lowering devices are a great nuisance and expense to the undertaker, they, with the grave lining and the mound cover, give a very pleasing effect, and I have yet to hear any person express an objection or dissatisfaction because they are used. The only objection to their use is the expense and trouble to the undertaker.

# PART THIRD.

## Specific Instructions for Beginners.

# PART THIRD.

SPECIFIC INSTRUCTIONS FOR BEGINNERS.

## TO EMBALM A BODY ARTERIALLY.

To embalm a body there are certain rules to be observed. They are simple in the extreme, and, once knowing them, you will never forget them.

In the first place, you are supposed to know if possible, what was the cause of death. Make selection of the artery to be used accordingly. Place your instruments in such position that you can reach any of them at will. See that everything you may require is in its proper position, even to the most minute articles. Decide which artery to use while you are selecting and placing your instruments.

Your selections being made, take a seat convenient to the selected artery, and, with a deliberate and steady hand, mark the outline of your incision by cutting lightly through the skin.

Having traced your work, force your way through the superficial fascia (or surface fat), taking care not to cut through the many little branches that are ramifying through it.

When you have dissected down through the superficial fascia, you will come to the deep fascia. These fasciæ are a protection to the arteries during life. Dissect through this, using the bone separator where you think there may be danger of cutting into any of the branches.

After passing through the skin, the superficial fascia and

the deep fascia, you come directly uopn the muscles of the parts which occupy their relative positions to the artery.

The artery being in most cases very deep seated, you will need to exercise great care in selecting the place for incision. You must locate the two edges of the muscles through which the artery passes, and separate them either with the bone separator or with the fingers.

You will find the vessels massed together, as it were, and running parallel with each other, perhaps half a dozen or more. Make your selection from this number, using the fingers of one hand, and pressing down with them a few inches distance from the point which you have selected for raising the artery, thus forcing the blood in the veins and in the artery to the point of selection, where you can see it distends the vessels. You can then easily distinguish it by its lighter red or pink color, the veins showing a very dark red, black, or perhaps a deep-blue color.

As the walls of the veins are not nearly so thick as the walls of the arteries, the blood in the veins shows through much more plainly, and therefore appears darker. Arterial blood is aerated by its circulation through the lungs, bringing it in contact with the air in the lungs during life, so that the contrast is greatest soon after death, and after a body has laid for 10 hours or more, the color of the blood in the arteries is about the same as in the veins, therefore it becomes necessary for you to judge from other signs which is the artery and which is the vein.

After you have made selection and separated the artery partially from its surrounding of fat, tissues, and accompanying veins, with perhaps a nerve or two, place an instrument of some kind, it is immaterial which one, under the artery, and, using gentle force and due caution, separate it entirely.

Then, while your instrument remains under the artery, run your fingers across it, feel of it, and thus make sure you have made no mistake. You will soon become accustomed to the feeling of the artery, and, after a little experience, can select it by the touch alone.

Next raise it to the surface, due care and caution being used here lest you rupture some little branch or vessel, causing the blood to ooze out, making the operation very tedious and troublesome. Care only is necessary to prevent such accidents.

After you have brought the artery to the surface, make another examination, as you cannot be too sure. Place the handle of an instrument underneath, then make the incision, exercising care not to cut all the way and sever the artery entirely, for then each end, by reason of its elasticity, would withdraw out of sight. Work your way gently, and you will eventually penetrate the true canal. As soon as you do so, in all probability, you will see a drop of arterial, or light-colored blood ooze out. This completes the work of raising the artery.

Your next step is to have the tube selected according to the size of the artery chosen, and insert it in the opening. Insert the tube well into the artery, pointing toward the trunk, if one of the lower arteries, and towards the heart if it be the Carotid.

Then pass a ligature or thread around it, and tie perfectly tight. Have no fear of cutting the artery with the thread if you use no more than ordinary exertion. Then pass a ligature or piece of thread around the other end of the artery, well up, and leave the ends of the strings in such a position that you can pick them up at a moment's notice.

The usual directions at this point are to leave the other end of the artery open until blood and finally fluid flows out,

thus serving as a guide to know that that part of the body has been injected. This, however, is not a satisfactory test, because at the point of injection the artery is much larger than it is nearer the smaller branches at the extremities, which would be in no wise effected. From the light recurrent pressure it is supposed to be sufficient to embalm them. It is true that the arm and hand seldom give any trouble if the body is buried within two or three days. This is because the substance is mostly muscular tissue, less liable to decay than the softer tissues of the body, or viscera, and when it is desired by the operator to be responsible for every part of the body's preservation, it is very desirable that he inject this artery towards its extremity, and he will not only have a feeling of conscientiously performing his duty, but will have the best test possible that it is the artery that he has been injecting, when he has established capillary circulation by so doing.

### ARTERIAL EMBALMING COMPLETE, OR HOW TO EMBALM A BODY THOROUGHLY.

It is desirable to remove the body from the bed to the embalming table, which should stand nearly level.

Remove all clothing at once, and place over the loins a sheet in order to prevent exposure.

Wash the body thoroughly, using an antiseptic soap with the water (hot or cold). When this is completed, and the body thoroughly cleansed, raise the board to an incline of about twelve or fifteen inches, the head elevated, the feet lowered, the object being to promote gravitation.

### SELECTING AN ARTERY FOR INJECTION.

Usually, the artery should be selected after the cause of death is learned and the condition of the body considered.

Having chosen which artery to use, dissect down until it is exposed to view, then raise the artery, and after entering the arterial tube as described on page 111, it is advisable for the operator to always start the injection, the tubing or syringe having been emptied of air and filled with fluid before being attached to the nozzle. This is very important, because air forced into the arteries would interfere with the circulation at some region, so that it would shut off certain parts from the fluid.

After the injection is proceeding nicely, the embalmer should turn his entire attention to watching the development of the capillary circulation. With a soft, moist sponge he can stimulate the circulation to any section or region.

The ears and face should be manipulated constantly so as to have a free and uniform circulation of fluid.

The finger nails and hands also should be taken care of, because they are the other *exposed parts* of the body for *funeral* purposes. It may be necessary to squeeze each finger nail forcibly, and manipulate it to encourage the circulation there, and have them nice and white, as they ought to be.

Continue the injection until a quart of fluid to about every 50 pounds of the body has been used.

If there is any swelling on the neck or distention of the veins, this is an indication that blood should be drained from the body, and if no previous arrangement has been made for the relieving of the blood by the vein tube, the Cardiac needle should be used between the second and third rib on the right side of the Sternum bone, rupturing either the Superior Vena Cava or right auricle of the heart, allowing the blood to drain away from the body. Continue thereafter to inject fluid until as much more fluid is injected as the amount of blood withdrawn.

The arterial injection of fluid may distend the organs of

the trunk of the body so that the air and gas surrounding them are forced to the top, and the distention of the abdomen would show that these gases should be relieved. When they are relieved, it is always well to inject some fluid.

It is well to introduce the perforated needle into the abdomen at the umbilicus or navel, and keep its point near the surface, to rupture the transverse colon. This will surely relieve enough gas to stop purging, in the event that this purging is caused by this pressure, which is usual.

Continue the arterial injection thereafter without further annoyance in this respect until it is concluded. After that, continue using the needle in the different regions of the abdominal cavity, following the point of the needle with your disengaged hand, over the abdomen.

If the case is Consumption, Pneumonia, or Pleurisy, it is well to direct the point of the needle towards the left lung, in the direction of the back, aspirating whatever gases you may find there, and repeat the operation in the other side in the same manner, withdrawing the needle from that region, but not withdrawing it altogether from the body, because the one entrance in the abdomen serves all purposes.

Then point the needle more directly in the abdominal cavity. Entrance to the stomach is gained through the puncture already made in the abdomen. Point your needle to the left and toward the upper part of the last or lowest rib. You will thus reach the stomach. Continue aspirating while you propel the point of the needle into all sections of the abdominal cavity. It is well to continue with the point of the needle near the surface, although always inside of the cavity.

If the arterial embalming is already completed, no particular fear of harm need be entertained. Persevere until you are sure that all of the gases within reach of your needle have escaped. The abdomen will now become very soft and

flabby. When this is the condition, the syringe or pump may be attached to the needle, and fluid injected in it until it is somewhat filled up again.

It may be, by attaching the pump, that some gases will escape, after which the operation of injecting more fluid may give the best results. After 1 to 2 quarts of fluid have been injected well into the cavities, the needle may be withdrawn, and it is best to leave the aperture open.

Now return to the artery, sew up the wound, and saturate white pieces of old muslin with fluid and place over the abdomen for disinfecting purposes.

If it is a thin, shriveled body, it is well to dilute your fluid with water to one-third or one-half its strength, and cover the face and hands with it. This keeps them nice and fresh and moist, or, what is better still, a grease properly prepared will prevent the drying and shriveling and hardening, and leave the face in a more natural condition.

Raise the hands over the chest or abdomen, and cover them as well.

You now can rest assured that your work has been well done, rearrange your room and cover the body with slumber robe or canopy.

## CAVITY EMBALMING.

Cavity embalming only, has been much criticised by practical men, and owing to the very many failures resulting when it was the *only kind* of embalming done, the argument has become so strong against it that many undertakers declare that "they would never do it." I presume that when they make the statement so emphatic, they mean that they *never depend upon cavity embalming alone,* and this I most emphatically endorse, because any embalmer who knows anything about anatomy realizes that cavity injection *alone* does

not affect any but that part of the body which the needle and the fluid pass through and comes into contact with. However, cavity embalming is an essential adjunct to arterial embalming, on some cases, particularly in sudden death, where the alimentary canal and stomach contain much vegetable substance. This is not disinfected by the fluid injected in the arteries, and to prevent it from fermenting and creating gases, which would be certain to produce very objectionable results, it is necessary to bring in contact with this vegetable matter, by the hollow needle, a sufficient quantity of fluid to thoroughly disinfect it.

In the event that a body is to be buried before decomposition or degeneration of the tissue is likely to occur in the extremities of the body, hands, face, etc., and where the undertaker is in a great hurry, or until he becomes familiar with arterial injection, the following is the proper mode of procedure:

Cleanse the mouth and raise the body to a half-sitting position, or, say, from twelve to fifteen inches. Wash it thoroughly, using for this purpose one-half water and one-half fluid, or a disinfectant soap, then extract the gases from the thoracic and abdominal cavities by means of the long, blunt, perforated embalming needle; the upper or thoracic cavities being emptied of their gases first, later the abdominal. To do this properly, puncture a hole at the umbilicus( or navel), and direct your needle towards the right nipple. Then manipulate it, *i. e.,* move it about in the cavity, and the gases will escape by aspirating. Press slightly on the breast to expedite matters. Withdraw your instrument, and direct it this time toward the left nipple, and repeat the manipulation. Never, however, draw the needle entirely out between the two manipulations, as the one puncture should answer all purposes; but be sure to keep your needle as near the

surface as possible, as you can then feel and direct it with your free hand.

Care should always be exercised, as, should the needle enter the cavity too low down, the fluid would escape from the upper into the lower cavity, and thus ruin all your work.

It does not require great skill to perform this operation, but it does demand care. Let your needle remain until you have injected the last cavity.

A quart in each of the upper cavities, making two quarts in all for the thorax, will ordinarily be sufficient.

There is a septum, a division, separating these two cavities, making an injection into each necessary.

Now withdraw your needle from the upper cavities, as you will have flooded the parts, thus preserving them as well as if they were enclosed in a vessel or bottle.

On withdrawing the needle from the upper cavities, direct it into the stomach, and extract the gases from that organ; and so on throughout the whole cavity of the abdomen, pointing and puncturing in every direction. Puncture the intestines thoroughly, both the large and smaller ones, so as to be sure of releasing the gases from all the parts. While puncturing with one hand, pass the other over the parts where the needle is being driven, and press down on them until the abdomen becomes soft and flabby. This condition will serve as evidence that your work is properly done. Refer to the plates of the Aid for the location of the stomach if you are uncertain. It is located on the left side, under the lower ribs. Next inject the fluid, causing your assistant to do the pumping while you direct the needle. Point it straight into the stomach, and force, perhaps, a half-pint of fluid into that organ. Then withdraw from the stomach, and continue all around through the abdominal cavity. The puncture made into the intes-

tines will admit the fluid, and you will thus completely saturate the entire cavity, filling it to its capacity. When you have injected a quart, or a quart and a pint, detach your needle from the pump, and allow the gases that have been driven to the surface to escape. Assist them by passing the hand gently over the whole surface. After completing this operation a second time, inject more fluid; possibly a quart can be injected into the space made vacant by the passing off of the surface gases.

Now transfer your operations, and inject a small quantity of the fluid down the throat and through the nostrils. To do this, introduce a nasal tube or good-sized catheter down the nostrils into the passage, then attach the pump and inject a limited amount, say a half-pint. If the fluid will not pass down readily, seize the Adam's apple, move it down and up, and, placing the other hand under the back of the neck, raise it, when the fluid will at once disappear down the passage into the lungs, and into the œsophagus, which is the canal by which the stomach is reached. Having now thoroughly embalmed the cavities, you may feel pretty sure of success, but it is always well to obtain some old pieces of muslin from the family, an old sheet for instance, the older the better; saturate with the fluid, and lay over the abdomen, covering from the lowest part to the highest; then lay a dry piece over the whole to prevent soiling or dampening the clothing. This will also act as a disinfectant, and guard against odors that might arise from gases accumulating in the cavity. Leave the puncture open, that the gases may escape into this first outer piece of saturated muslin. It will absorb and destroy them, and also bleach the body to a certain extent. In any event, it is a good plan to follow, and causes no inconvenience, even should it remain under the clothing with which the body is dressed.

I have used it successfully, and can recommend it to all as a valuable addition to temporary embalming. Next give attention to the face and hands. For this purpose use the same fluid, but reduce to about one-half of its ordinary strength, i. e., about one pint of fluid to a pint of water. Place in a bowl under the cooling board. Saturate a small piece of muslin (though a cotton mask is far superior, as it conforms to the features better), place it on the face, and spread all over it; but be sure the tip of the nose is not flattened, and see that it is thoroughly wet. Lay it very smoothly, so there may be no wrinkles.

Next, wrap the hands in the same manner (muslin or lintine answers this purpose better than cotton), then place them on the breast to prevent discoloration by the blood which may gravitate downward. Leave the bowl of fluid-mixture under the board. Cover the body, leave it on the same incline, darken the room, and see that there is ample circulation of air. Return the next day and look over your work. Saturate your pieces of muslin and cotton again, and prepare the body for the casket ready for its interment. Cavity embalming is not recommended by practical embalmers, as failures are frequent, and it requires about the same time to accomplish as does arterial embalming. Arterial embalming is to be recommended even in the simplest cases. Do not assume, however, that cavity embalming is of no value. It is often of great importance and necessary, in conjunction with arterial embalming.

## LONG TIME EMBALMING.

To embalm a body so that it will not change in appearance for an indefinite period, requires an experienced hand, an adept in the profession, and he is required to have good judgment, and a head full of strong common sense.

But, if the following directions be followed to the letter, there need be no hesitancy on the part of the embalmer. In the first place, then, the body, having been removed from the death-bed to an embalming table prepared for its reception (which should be nearly level), should be disrobed of all its clothing so as to be wholly nude. Wash thoroughly with a solution of embalming fluid and water (warm or cold), after which throw a light sheet over the loins and extremities. The eyes should then be carefully closed, using eye-caps or strips of paper, extending from the upper to the lower lids, with the lids closed over them, care being taken that no folds or wrinkles are in the paper.

Then a nasal tube should be passed into the nostrils, and fluid injected through them into the windpipe, so that it may reach the lungs. A pint of fluid will probably be sufficient for this, but the operator's judgment must guide here, as there can be no inflexible rules laid down as to quantities, because of the variations in the size of the human body. The fluid introduced into the nose will also enter the alimentary canal, and pass down into the stomach, disinfecting the passages in its course. If, however, the fluid does not flow down easily and of its own accord, create an artificial deglutition (act of swallowing) by passing one hand under the back part of the neck and raising neck and head about two inches from the level of the board, using the other hand to work the epiglotis up and down. In this way the passage will be opened, and the fluid passes down. Having completed this operation, which, by the way, is a very important one, elevate the body on the table to a height of about fifteen inches, and proceed to raise the Axillary artery and vein. Place the tube in the canal of the artery, directed towards the body. Make that end of the ligature (or string) fast, tying it securely, thereby securing the tube in the canal.

Then attach the tube, and proceed to inject very slowly at first. The fluid, entering the artery, distributes itself through all the arteries and their branches at once, just what is desired. Keep up the injection slowly for a short time, yet making sure, by watching the course of the arteries, that they are receiving the fluid. Proceed with the arterial injection, progressing very slowly, as the fluid must be given opportunity to enter the minute capillaries and veins. As they receive the fluid they become distended. The process is slow and tedious, plenty of time and patience are required; see that the superficial veins are distended, your object being to reach all parts of the body through the arteries, capillaries, and veins, with as much fluid as possible. Continue to inject until you have an amount of fluid which, according to your judgment, is sufficient for the time being.

Then detach the tube, and place a cap or cutoff over the artery tube to prevent the escape of the fluid. The Axillary vein tube should be introduced at the same time with the Axillary artery tube, so that the blood may be drained at any time it is deemed advisable.

Cavity embalming should be avoided, as there is always more or less danger of rupturing the systemic circulation. It is seldom found necessary, but if done, the greatest care should be observed in the use of the needle, not to rupture *unnecessarily* the arteries and veins, because, it may be that the reinjection of the arteries is needed; if it is also desirable, however, to remove the gases from the body, and there is any great distention of the abdomen, and the pressure of the gases causes the walls of the abdomen to retard the circulation through its surface, but as the large arteries and veins are all deep seated, and lie near the backbone, the operator may avoid rupturing them. He, therefore, is permitted to enter the needle.

Let me repeat, keep your needle as near the surface as possible, so as to avoid any leakage from the upper into the lower cavity through the diaphragm. Continue this operation all around, as you did when puncturing the organs and intestines for gases. Use your own judgment as to the amount of fluid to be passed into the cavities, as you did in the case of the arteries. Ordinarily you should use, altogether, about six quarts on the first day. You next withdraw your needle part way, and permit the surface gases to escape. Probably they will pass off in large quantities. Then take some old muslin or towels, and saturate them thoroughly with the fluid, and then lay them over the whole abdominal surface next the skin. Now wrap the hands in two or three thicknesses of muslin saturated with the solution made for facial applications. It should be one-half fluid and one-half water. Dip the cloths in this solution, which should be kept in a bowl under the embalming table. Make a mask of cotton, and saturate with the solution. Place it over the face, fitting it to the parts by pressing it in and around the nose, and down upon the eyes, extending it from the top of the forehead to the chin, and down the neck, and from the back of one ear to the back of the other. Place the hands over the breast. Do not allow them to lie by the side of the body. Leave the room in good order, and the body in the same condition. Shade the windows until the room is dark, and see that there is a full circulation of air. Assure the family that all is right, and state that nothing must be disturbed, and leave it until you call the next day, as it is better to keep the air from the face and hands for the first twenty-four hours.

On your return the next morning remove the mask, and see that all is right about the face and hands; saturate it again: make thorough examination of the body: see that

the tube you left in the artery is in position, and that there is no leakage anywhere. Call again in the evening, and make another thorough examination, and moisten the mask (not too wet) and leave it for the night. Call again the second morning, and bring with you more fluid and your instruments; inject the artery again with perhaps one or two quarts, as the case may be. Look to the cavities, introduce your blunt needle, and manipulate it in all directions. Extract whatever gases have accumulated in the meantime; be sure of a thorough and complete examination, slighting nothing, even to the minutest detail. Withdraw the fluid from the cavity by means of your pump (as in dropsy), and introduce a fresh quantity, perhaps one to two quarts, thus destroying the possibility of more gases accumulating. Replace the saturated towels, and see that the tubing in the artery is all right. See again to darkening the room, and continue the circulation of air; leave all in good order, and call the next day. By this time, all arrangements having been made for the funeral, you will be notified to that effect. Govern yourself accordingly. If there be no particular haste about dressing the body, leave everything as it is until you are ready to dress it for the casket. Just before dressing the body, saturate the towels that are on the abdomen, and leave them there. Put clothing on over them; sprinkle a little fluid around the bottom of the casket, among its linings, or place some within at the foot, or do both. You might use the mask for face again if there is no glass to keep the air out. This is quite an important duty, as air will cause a change in some cases; therefore it is well to be on the safe side, and preserve the mask for use at any chance opportunity that may come to you as at night time, removing it in the morning. If everything is in order, as it should be, proceed with your final preparations. The body

can now be kept almost indefinitely, and may lie in state, be transported from place to place, or be shipped across the ocean and back. It should be in a perfect state of preservation, and will not change in any way, if the face be kept from the air. Keep a glass over the upper portion of the coffin.

## FOR INFECTIOUS AND CONTAGIOUS DISEASES.

The Board of Health rules are really those that should be used to generally guide you in the treatment of contagious and infectious diseases. In many places, however, the Undertakers are called on to exercise care and caution and to do the disinfecting. When this is so, the first thing to be done is the disinfection of the room and clothing with which he himself has personally to come in contact, and of which we will speak later.

After having prepared the atmosphere so that it is safe for him to go in, the body should be removed from the bed and the clothing boiled in water for at least 20 minutes, or else saturated in a solution containing 1 part of corrosive sublimate to 500 parts of water. To make one gallon of such solution use ¼ oz. corrosive sublimate and ¼ oz. of sal ammoniac, dissolved in the water (a gallon). The clothing should be allowed to remain in the solution a half hour. The body should be thoroughly bathed with a strong antiseptic solution, or with embalming fluid, which contains Formaldehyde, the orifices of the body closed with cotton saturated with embalming fluid, or with a strong antiseptic solution as above. A thorough arterial and cavity injection should be given the body, which should then be wrapped in a sheet which has been saturated with corrosive sublimate solution, and so kept until placed in the casket for burial.

## DIRECTIONS FOR DISINFECTING ROOMS, ETC.

Close all windows and doors in the rooms to be disinfected, also all large openings, radiators, chimneys, etc. Closing small cracks and very small openings, when there are but few of them, is only necessary in extremely large rooms or wards. (Adhesive plaster is useful for closing small openings, etc.) The gas is generated so very rapidly in the apparatus that it has sufficient time and volume to kill all bacteria exposed to its action before enough of it can escape through minute crevices, or before it could have been sufficiently diluted by admixture with the outside air by ventilation through the walls of the room. The Glycerine, probably by preventing or very considerably retarding polymerization, and on account of its slight filmy (yet imperceptible) deposit on the articles to be disinfected, appears to prolong the action of the Formaldehyde in its active state in immediate contact with the bacteria causing infection, and tends to favor bacterioidal action and penetration, even after the operation is completed.

The linen, quilts, blankets, etc. (unless they have been removed for steam disinfection), should be stretched out on a line in order to expose as much surface as possible to the action of the gas. They should never be thrown in a heap.

Curtains, furniture, hangings, gilt or tinselled ornaments, etc., need not be removed from the room, as Formaldehyde gas will not injure the color or material of any fabric used for room decoration, furniture, clothing, etc.

Books supposed to have been infected by patient should be suspended by their covers, so that the pages are open and freely exposed.

## Amount of Solution Required.

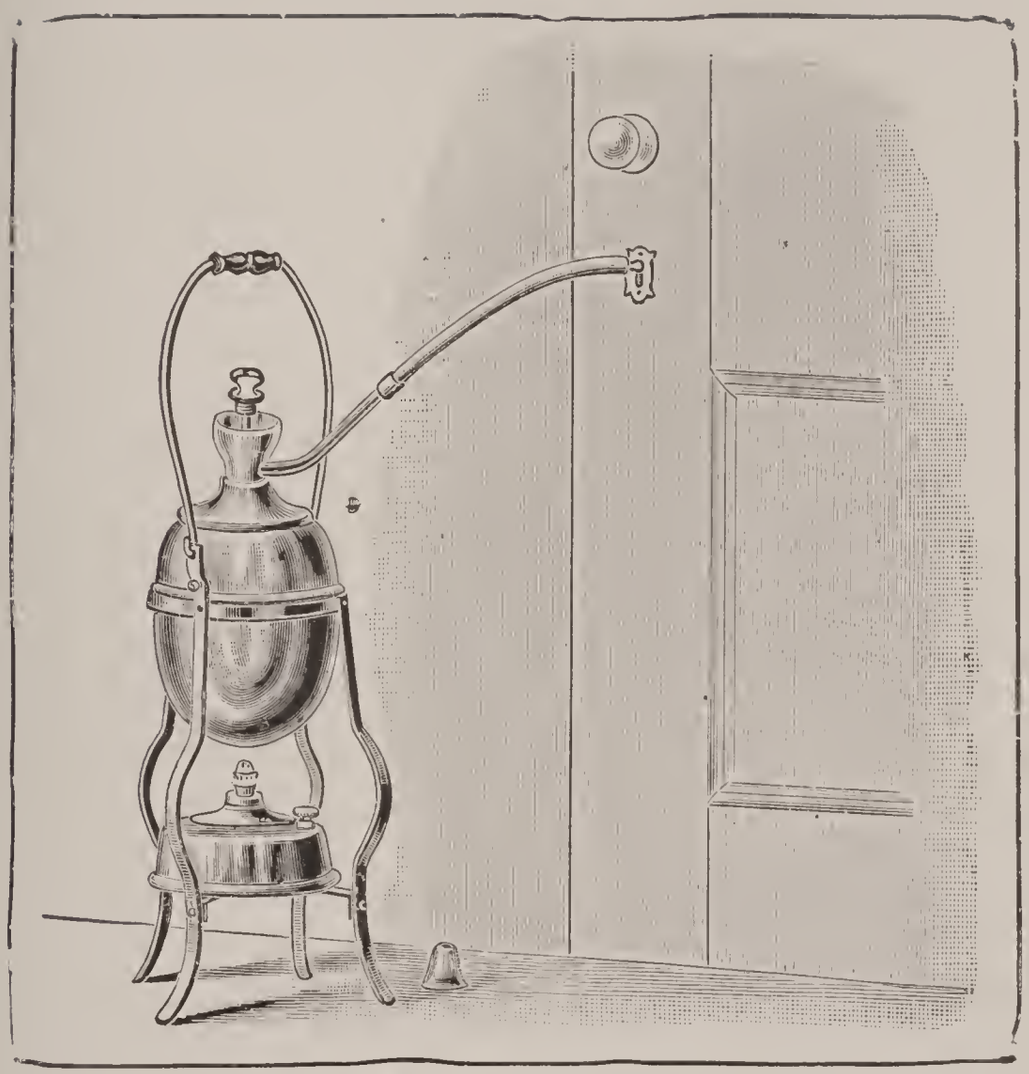
For practical house disinfection, when the temperature of interior of room is not below the freezing point, 10 oz. by weight (8 oz. by measure) of solution are required for every 1,000 cubic feet of space. (If the infection is known to have been anthrax, use 20 oz. of solution per 1,000 cubic feet, a room 10 feet square with 10 feet ceiling.

Rooms of 3,000 cubic feet and under should remain closed for at least three hours after operation of generator has been discontinued. Rooms of larger capacity, halls, wards, etc., should remain closed at least twelve hours.

In cases of anthrax infection the room disinfected should remain tightly closed not less than twenty-four hours.

The Formaldehyde or large retort has a capacity of a little over a half gallon, but should not be filled more than three-fourths full, so that space may be left for ebullition. If only a pint or quart is to be used in each room, vaporization (boiling) will occur more quickly if only such amount is put in the retort. When steam comes out of the stopper (the level indicator) it shows that the retort is almost empty, and should be refilled by unscrewing the cork, on the funnel-shaped opening of the top, which is large enough to serve as a funnel.

The Alcohol Lamp holds a pint, which is sufficient to burn for three hours, or vaporize 3 pints of Foramldehyde. There is no danger in leaving this lamp full, though it should not run over. When filling, the burner is lifted right out of the lamp, when there is abundant opening for pouring into it.



FORMALDEHYDE LAMP.

# PART FOURTH.

## The Embalmer's Guide.

*[Designed to accompany Eckels' Anatomical Aid—Courtesy of the Western Publishing House.]*

# PART FOURTH.

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## THE BLOOD CIRCULATION.

In order to comprehend most fully and easily the art of embalming, it is essential that one should know something of the anatomy of the human body, its organs, and the functions or duties performed by each. This necessitates a brief examination of each part separately, and, as the blood is one of the most important, let us examine its work during life and its condition after death.

Blood is a thick, opaque fluid, varying in different parts of the body from a brilliant scarlet to a dark purple color. In its normal state, it forms about ten per cent. of the bodily weight. Thus, if a man weighs one hundred and fifty pounds, the weight of his blood would be about fifteen pounds.

The circulation of the blood throughout the body requires only about twenty seconds. It is carried to the lungs by the pulmonary arteries (5, Blood Formation) as venous blood, and is carried from the lungs to the left auricle (26) of the heart through the pulmonary vein (17), then carried to the left ventricle (28) of the heart, then to the aorta (4), and thence throughout the entire or general system.

Within a few hours after death the blood becomes thickened or coagulated on account of its remaining quiet

in the veins. The arteries, as a rule, empty themselves into the veins, capillaries, and tissues of the body. Therefore, in preparing to embalm a body, we ordinarily find them empty, although, in some cases, small quantities of blood are retained.

Water forms about seventy per cent. of the human body, and the remaining thirty per cent. is distributed among the tissues, the bones and other organs of the human frame.

## DESCRIPTION OF THE ARTERIES.

(See plates in the Aid.)

The arteries are cylindrical, tubular vessels, which serve to convey blood from both ventricles of the heart to all parts of the body. They are strong, elastic, and, when empty, preserve their cylindrical form, and are composed of three distinct coats: the internal serous, the middle fibrous, and the external cellular coat. The arteries are recognized by their pink color in strong contrast with the dark color of the veins, are of various sizes, some of them being of extremely large, and others of very small, caliber.

They contain no valves, so that, when injected, they distribute the fluid throughout the entire system to the remotest corners. They will hold from two to six quarts of fluid, and often much more. During the embalming process the arteries may receive daily injections, using a small quantity at a time. Care should be taken that the injecting tube is placed in the canal of the artery, and not between the tunics or coverings. The arteries empty themselves into the capillaries, which are microscopic vessels, in diameter about one three-thousandth of an inch, their size varying in different parts of the body. The smallest capillaries are those of the brain and of the

mucous membrane of the intestines. Arteries are, as a rule, deep seated, in order that they may be less exposed to injury.

The distribution of the systemic arteries is like a highly ramified tree, the trunk formed by the aorta (4, Blood Formation), and its many ramifications forming the branches. The arteries divide and subdivide, running into the most distant parts of the body, the larger arteries usually occupying the most protected situations. Generally the larger arterial branches pursue a perfectly straight course, but in certain places and situations they are very tortuous ; thus the facial artery, in its course over the face, the internal carotid, and the vertebral arteries just before they enter the cavity of the skull, describe a series of curves which are evidently intended to diminish the velocity of the current of blood by increasing the extent of surface over which it moves.

### THE PULMONARY ARTERY.

(B, plate of Lungs; also 5, Blood Formation.)

The pulmonary artery conveys the impure blood from the right side of the heart to the lungs. It is a short, wide vessel about two inches in length, and rises from the left side of the base of the right ventricle (27, Blood Formation) in front of the aorta. It ascends upward, backward and to the left side, and winds spirally in front of and then to the left of the ascending part of the arch of the aorta (4, Blood Formation) as far as the under surface of the transverse portion of the arch, where it divides into two branches of nearly equal size — the right and left pulmonary arteries.

The right pulmonary artery (5, Blood Formation) is longer and larger than the left, runs outward behind the

ascending aorta and superior vena cava (13, Blood Formation) to the root of the right lung, when it divides into two branches. The left pulmonary artery (5, Blood Formation) passes in front of the descending aorta.

## THE AORTA.

(See Blood Formation in Aid.)

The aorta (4) is the main trunk of a series of vessels, which, arising from the heart, convey the red oxygenated blood to every part of the body for its nutrition. This vessel commences at the upper part of the left ventricle, and, after ascending for a short distance, arches backward and to the left side over the root of the left lung, descends within the thorax, passes through the aortic opening in the diaphragm, and enters the abdominal cavity, terminating opposite the fourth lumbar vertebra (12, Skeleton plate), there dividing into the right and left common iliac arteries (F, back plate Body).

The portion of the aorta situated in the thorax is called the thoracic aorta (6, Blood Formation), and, after passing through the diaphragm and entering the abdomen, it is called the abdominal aorta (10, Blood Formation). The aorta, and more especially its arch, is frequently the seat of disease, aneurisms often occurring at this point.

The branches given off from the arch of the aorta are five in number, the *right* and *left coronary*, the *innominate* (2, Blood Formation), the *left common carotid* (1, Blood Formation), and the *left subclavian* (3, Blood Formation). The coronary arteries (Heart plate) supply the heart, and arise near the commencement of the aorta, just above the free margin of the semilunar valves (Heart plate). The right coronary artery, about the size of a quill, rises from

the aorta immediately above the right semilunar valve. between the pulmonary artery (B, Heart plate) and the right auricular appendix (b, Heart plate). It passes through the right side in the groove between the right auricle and ventricle, and, curving around the right border of the heart, runs along its posterior surface as far as the posterior interventricular groove. It then divides into two branches, one of which continues in the groove between the left auricle and ventricle, and anastomoses with the left coronary; the other descends along the posterior interventricular furrow, and supplies branches to both ventricles and to the septum. The left coronary artery is larger than the right, rises immediately above the free edge of the left semilunar valve, a little higher than the right, passes between the pulmonary artery (B, Lung plate) and the left appendix auriculæ (d, Heart plate), and descends toward the anterior interventricular groove, where it divides into two branches. One branch passes transversely outward in the left ventricular groove, and winds around the left border of the heart to its posterior surface; the other descends along the anterior interventricular groove to the apex of the heart, where it anastomoses with the descending branches of the right coronary artery. The left coronary artery supplies the left auricle and its appendix, both ventricles, and a number of small branches to the pulmonary artery and the commencement of the aorta.

The innominate artery (2, Blood Formation) is the largest branch given off from the arch of the aorta. It rises from the commencement of the transverse portion in front of the left carotid artery (1, Blood Formation), ascends to the upper border of the right sterno-clavicular articulation, and divides into the right common carotid

(1, Blood Formation) and subclavian arteries (3, Blood Formation). Of the common carotid arteries, the right rises from the arteria innominata behind the right sterno-clavicular articulation; the left, placed more deeply in the thorax, ascends outward from the arch of the aorta to the root of the neck. In front it is separated from the first piece of the sternum by the sterno-hyoid and the sterno-thyroid muscles, and the left innominate vein (14, Blood Formation). In the neck, the two common carotids resemble each other so closely that one description will answer for both. Each vessel passes upward from behind the sterno-clavicular articulation (9, plate of Ribs-Thorax) to a level with the upper border of the thyroid cartilage (d, plate of Muscles), where it divides into the external and the internal carotid arteries.

The course of the common carotid is direct from the sternal end of the clavicle (f, Muscles) to the mastoid process above; this point is indicated by the lower lobe of the ear. At the lower part of the neck, the common carotid artery is very deeply seated, being covered by the superficial fascia, platysma, deep fascia, the sterno-mastoid (18, Muscles), sterno-hyoid (19, Muscles) and sterno-thyroid (d, Muscles) muscles. In the upper part of its course, near where it terminates, it is quite superficial. The external carotid artery (19, Head plate) commences opposite the upper border of the thyroid cartilage (d, muscles), takes a slight curved course, runs upward and forward, then inclines backward, and then divides into the temporal (18, Head plate) and internal maxillary arteries (35 and 23, Head plate). The facial artery (20, Head plate) arises a little above the lingual, and runs forward and upward beneath the lower jaw, then curves upward over the body of the jaw, runs forward and upward,

and crosses the cheek to the angle of the mouth, passes up alongside of the nose, and, under the name of the angular artery, terminates at the inner canthus of the eye. The facial artery, both in the neck and on the face, is very tortuous and very superficial; its pulsations may be distinctly felt by slight compression against the bone. In its course over the face, it is covered by the fat of the cheek and is accompanied by the facial vein (17, Head plate) throughout its entire course, though the vein is not so tortuous as the artery. The anastomoses of the artery are very numerous.

The occipital artery (3, Head plate) arises from the posterior part of the external carotid, opposite the facial. At its origin, it is covered by the posterior belly of the digastric and stylo-hyoid muscles, and part of the parotid gland; higher up it crosses the internal carotid artery and the internal jugular vein, then ascends to the interval between the transverse process of the atlas, and the mastoid process of the temporal bone, then changes its course and passes vertically upward. The temporal artery (7 a, Incision plate) is the smaller of the two terminal branches of the external carotid artery, and appears, from its direction, to be the continuation of that vessel. It divides into two branches, an anterior and a posterior.

The anterior temporal inclines forward over the forehead and anastomoses with the supraorbital and frontal arteries; the posterior temporal is larger, curves upward and backward along the side of the head, and inosculates with its fellow of the opposite side and with the posterior auricular and occipital arteries (3, Head plate).

The internal maxillary (35, Head plate) is the largest of the terminal branches of the external carotid artery, passes inward at right angles from that vessel to the inner side

of the neck, and supplies the deep structures of the face. The internal carotid artery commences at the bifurcation of the common carotid artery, opposite the upper border of the thyroid cartilage, and runs perpendicularly upward in front of the transverse processes of the three upper cervical vertebræ, to the carotid foramen in the petrous portion of the temporal bone; after ascending for a short distance, it passes forward and inward through the carotid canal and enters the skull.

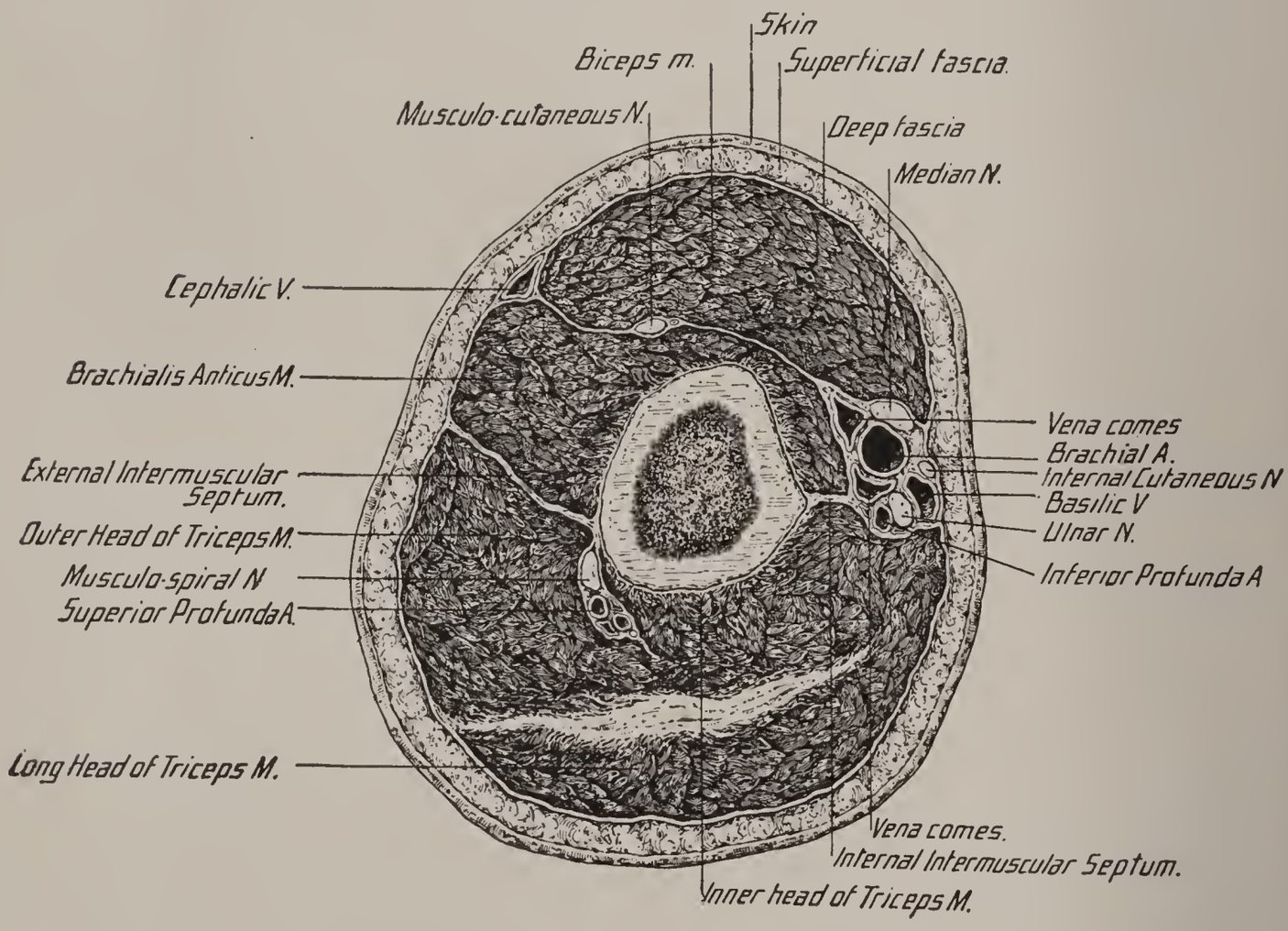
The internal carotid artery supplies the anterior part of the brain, the eye, and its appendages, and sends branches to the forehead and the nose, its size in the adult equaling that of the external carotid. Its course is curved, thus diminishing the velocity of the current of blood by increasing the extent of surface over which it moves. It is divided into four portions, the *cervical*, the *petrous*, the *cavernous*, and the *cerebral*.

The cervical portion is superficial at its commencement, being contained in the superior carotid triangle, and lying on the same level as the external carotid; but back of that artery it passes beneath the parotid gland, and is crossed by the external carotid and occipital arteries. When the internal carotid artery enters the canal in the petrous portion of the temporal bone, it first ascends a short distance, then curves inward, and again ascends as it leaves the canal to enter the skull cavity. The cavernous portion at first ascends to the posterior clinoid process, then passes forward by the side of the body of the sphenoid bone. The cerebral portion of the artery is on the outer side of the optic nerve.

The ophthalmic artery rises from the internal carotid artery just as that vessel is emerging from the cavernous sinus on the inner side of the anterior clinoid process, and

# PRACTICAL ANATOMY FOR THE EMBALMER.

A Few of the Parts from a Human Subject in twenty Dissections, showing the exact positions of the Arteries, Veins, Nerves and Muscles throughout the human body, also the organs of the Thoracic and Abdominal Cavities in their normal places.




TRANSVERSE SECTION IN "MIDDLE THIRD" OF ARM WHERE THE BRACHIAL ARTERY IS USUALLY RAISED.

enters the orbit through the optic foramen. The frontal artery (Forehead), one of the terminal branches of the ophthalmic, passes from the orbit at its inner angle, and, ascending on the forehead, supplies the muscles, and anastomoses with the supraorbital artery (Eye). The nasal artery, the other terminal branch of the ophthalmic artery, emerges from the orbit above the tendo oculi, and divides into two branches, one of which anastomoses with the angular artery; the other runs along the dorsum of the nose, supplies its entire surface, and anastomoses with the artery of the other side.

The cerebral branches of the internal carotid are, the *anterior cerebral*, the *middle cerebral*, the *posterior communicating*, and the *anterior choroid*. The anterior cerebral (Head plate) rises from the internal carotid at the inner extremity of the fissure of Sylvius, passes forward between the two anterior lobes of the brain, soon after its origin being connected with the vessel of the opposite side by a short anastomosing trunk about one inch in length. The anterior communicating artery (Head plates) is a short branch about one inch in length, but of moderate size, connecting the two anterior cerebral arteries. Across the longitudinal fissure, the two arteries join to form a single front, which afterward subdivides, or the vessel may be wholly or partially subdivided into two portions. The middle cerebral is the largest branch of the internal carotid, passes outward along the fissure of Sylvius, where it divides into three branches: an anterior, which supplies the pia mater; a posterior, which supplies the middle lobe; and a median branch, which supplies the small lobe at the outer extremity of the Sylvian fissure. The posterior communicating artery arises from the back part of the internal carotid, runs directly backward and anas-

tomoses with the posterior cerebral, a branch of the basilar. This artery varies considerably in size, occasionally being so large that the posterior cerebral may be considered as arising from the internal carotid, rather than from the basilar.

The anterior choroid (Head plate) is a small but constant branch which rises from the back part of the internal carotid near the posterior communicating artery; passing backward and outward, it enters the descending horn of the lateral ventricle, beneath the edge of the middle lobe of the brain

## THE BLOOD-VESSELS OF THE BRAIN.

The arteries of the brain are derived from the internal carotid and the vertebral arteries. On the left side, these vessels rise at such an angle that the blood current is much more direct than on the right; thus accounting for the larger size and development of the left hemisphere. At the base of the brain, these four vessels form the circle of Willis. This circle consists of two sets of vessels, the anterior or carotid set, from which arise the anterior and middle cerebral arteries (Head plate), and the posterior or vertebral set, consisting of the basilar and posterior cerebral arteries. Each set has a free anastomosis from side to side.

## ARTERIES OF THE UPPER EXTREMITY.

(See plates in Aid.)

The artery which supplies the upper extremity continues as a single trunk from its commencement down to the elbow; but different portions of it have received different names according to the region through which it passes. That part of the vessel which extends from its origin to

the lower border of the first rib is termed the subclavian artery (3, Blood Formation). Beyond this point to the lower border of the axilla it is termed the axillary artery (A, plate 4, Upper Extremity), and from the lower margin of the axillary space to the bend of the elbow it is termed the brachial artery (A, plate 2, Upper Extremity). At this point the single trunk terminates by dividing into two branches, the radial (B, plate 2, Upper Extremity), and the ulnar (G, plate 2, Upper Extremity), an arrangement precisely similar to that occurring in the lower limb.

The subclavian artery (3, Blood Formation) on the right side arises from the arteria innominata (2, Blood Formation) opposite the rightsterno-clavicular articulation, and on the left from the arch of the aorta (4, Blood Formation); therefore these two vessels in the first part of their course differ in their length, their direction, and their relation with neighboring parts. The right subclavian artery (3, plate, Blood Formation) (4a, Incision plate) arises from the arteria innominata (1, Blood Formation) opposite the right sterno-clavicular articulation, passes upward across the root of the neck, and terminates at the inner margin of the scalenus anticus muscle, and in this part of its course ascends a little above the clavicle (5, Rib plate), the extent to which it does so varying in different cases. It is crossed by the internal jugular (16, Blood Formation) and vertebral veins. The left subclavian artery (3, Blood Formation) arises from the end of the transverse portion of the arch of the aorta (4, Blood Formation), ascends to the inner margin of the first rib, is longer than the right, situated more deeply in the cavity of the chest, and directed almost vertically upward, instead of arching outward like the vessel of the opposite side.

The vertebral artery (Blood Formation) is the first and

largest branch of the subclavian, rises from the upper and back part of that vessel, passes upward and enters the foramen in the transverse process of the sixth cervical vertebra. It ascends through the foramina in the transverse processes of all the vertebræ above the sixth, and above the upper border of the axis it inclines upward to the foramen in the transverse process of the atlas, through which it passes. It enters the skull through the foramen magnum, then passes upward to the front of the medulla oblongata (45, Head plate), and unites with the vessel of the opposite side at the lower border of the pons Varolii to form the basilar artery. Within the skull it winds around the medulla oblongata. The basilar artery (Head plate), so named from its position at the base of the skull, is a single trunk formed by the two vertebral arteries. It extends from the posterior to the anterior border of the pons Varolii, and has several branches ; namely, the *transverse*, the *anterior inferior cerebellar*, *superior cerebellar*, and the *posterior cerebral*. The transverse branches supply the pons Varolii and adjacent parts of the brain ; the superior cerebellar (Head plate) rises near the termination of the basilar, and, on arriving at the upper circle of the cerebellum, they divide into branches which ramify in the pia mater and anastomose with the inferior cerebellar ; the posterior cerebral, the two terminal branches of the basilar, are larger than the preceding, anastomose with the anterior and middle cerebral artery, and near their origin receive the posterior communicating arteries from the internal carotid, and give off numerous branches which enter the posterior perforated space. The remarkable anastomoses which exist between the branches of the internal carotid and vertebral arteries at the base of the brain, constitute the circle of Willis. This circle is formed in

front by the anterior cerebral arteries, and branches of the internal carotid, which are connected together by the anterior communicating artery; behind by the two posterior cerebral branches of the basilar, which are connected through the internal carotid by the posterior communicating artery. It is by this anastomosis that the cerebral circulation is equalized and provision made for effectually carrying it on if any of the branches should be damaged or obliterated. The internal mammary artery (Breast) arises from the under surface of the first portion of the subclavian artery, descends behind the clavicle to the inner surface of the chest, rests against the costal cartilages a short distance from the margin of the sternum, and divides into two branches.

The axillary artery (A, plate 4, Upper Extremity), the continuation of the subclavian, commences at the lower border of the first rib, and terminates at the lower border of the tendon of the teres major muscle, where it takes the name of the brachial (B, plate 4, Upper Extremity). Its direction varies with the position of the limb, as, when the arm lies by the side of the chest, the vessel forms a gentle curve, the convexity being upward; when the limb is directed at right angles with the trunk, the vessel is nearly straight; when elevated, it describes a curve. At its commencement, the artery is very deeply situated, but near its termination is quite superficial, being covered only by the skin and fascia. The subscapular (plate 4, Upper Extremity) is the largest branch of the axillary artery, arises opposite the lower border of the subscapularis muscle, and passes downward. The posterior and anterior circumflex arteries wind around the neck of the humerus; the posterior circumflex (1, plate 4, Upper Extremity) is the larger of the two, rises from the back part

of the axilla, and, passing backward with the circumflex veins, anastomoses with the anterior circumflex (A, plate 4, Upper Extremity) and thoracic arteries, and with the superior profunda branch (L, plate 4, Upper Extremity) of the brachial artery; the anterior (H, plate 4, Upper Extremity) arises just below that vessel from the outer side of the axillary artery.

The brachial artery (B, plate 4, Upper Extremity) commences at the lower margin of the tendon of the teres major, and, passing down the inner and anterior aspect of the arm, terminates about one-half inch below the elbow, where it divides into the radial (B, plate 2, Upper Extremity) and ulnar arteries (G, plate 2, Upper Extremity). Like the axillary, the direction of the brachial artery varies with the position and situation of the arm; if the arm be directed downward by the side of the body, the artery takes a spiral course, and is much deeper seated; but, if the arm is held in a horizontal position or directly outward with the palmar suface of the hand upward, its course is almost on a straight line and nearer the surface, making it more superficial, and decidedly easier for the operator to reach. When about to take up the brachial artery for an injective point, turn the hand with the palm upward, as this will bring the artery to the desired position. In the upper part of the arm, the artery lies internal to the bone; but below it is in front, lying between the border of the biceps and triceps muscles, which make a good landmark; it is always accompanied by two companion veins, the venæ comites (5, plate 2, Upper Extremity), and the nerve of the arm. These are sometimes found in one sheath, and can be separated very easily. For the purpose of injecting, the brachial artery is frequently used by embalmers, as it is easily found, and affords the operator a chance to hide or cover up his work, which in

some cases is very important. In embalming a child, however, the brachial artery would practically be useless, as its caliber is so small. With children it is advisable to use the carotid or the femoral artery, preferably the former as there is no danger of injury or of discoloration. Give the tubing a downward course, and naturally the fluids distribute to the body first, the upper extremities receiving the injection more slowly, as the branches take off the recurring current. Afterwards inject a few ounces of fluid up towards the head, being careful not to use more than necessary. In raising the brachial artery for embalming purposes, it is well to make incision about two inches below the axilla, as in that position the small branches can be avoided and considerable leakage be prevented. The radial artery (B, plate 2, Upper Extremity), though smaller, appears from its direction to be the continuation of the brachial artery. It commences at the bifurcation of the brachial, just below the bend of the elbow, and passes along the radial side of the forearm to the wrist, then winds backward around the outer side of the wrist beneath the extensor tendons of the thumb, and finally passes forward between the two heads of the first dorsal interosseous muscle into the palm of the hand, where it crosses the metacarpal bones to the ulnar border of the hand to form the deep palmar arch (G, plate 2, Upper Extremity). At its termination it inosculates with the deep branch of the ulnar artery.

The radial artery is accompanied by the radial nerve (1, last plate, Upper Extremity), lying on the radial side of the radial artery, and by its two companion veins, the venæ comites. If occasion should require, the radial artery may be used for injecting purposes, sometimes with very good results ; but, as it is smaller than the ulnar, and exposed to view at the wrist, where it is quite superficial,

this is not advisable where a larger and more convenient artery is available. The operation, also, would necessarily be very slow.

The ulnar artery (G, plate 2, Upper Extremity), the larger of the two subdivisions of the brachial, commences a little below the bend of the elbow, and crosses the inner side of the forearm obliquely inward to the commencement of its lower half; it then runs along its ulnar border to the wrist, crosses the annular ligament on the radial side of the pisiform bone, and passes across the palm of the hand, forming the superficial palmar arch. This arch describes a curve with its convexity to the fingers and to the space between the ball of the thumb and the index finger, where it anastomoses with a branch from the radialis indicis, thus completing the arch. If the thumb be placed at right angles to the hand, its position will be indicated by a line drawn along the lower margin of the thumb, across the palm. It is covered by the palmar fascia, the palmaris brevis and integument. The deep palmar arch is situated about one finger's breadth nearer the carpus. The ulnar nerve (K, plate 3, Upper Extremity) accompanies the artery (E, plate 3, Upper Extremity) a short part of its course. The ulnar artery gives off ten branches, of which those in the forearm are called the *anterior ulnar recurrent* (G, lower part plate 4, Upper Extremity), the *posterior ulnar recurrent*, the *interosseous* (H, lower part plate 4, Upper Extremity), the *anterior interosseous*, the *posterior interosseous*, and the *muscular;* those in the wrist are the *anterior carpal* and the *posterior carpal;* those in the hand are the *deep* or *communicating* branch and the *digital.*

The anterior ulnar recurrent branch rises immediately below the elbow joint, passes inward, and supplies the brachialis anticus and pronator radii teres muscles; the

posterior ulnar recurrent branch is much larger, and, rising a little lower, passes backward and inward beneath the flexor sublimis, and ascends behind the inner condyle of the humerus, supplying the neighboring joints and muscles, and anastomosing with the inferior profunda and interosseous recurrent arteries. The interosseous artery (H, lower part Upper Extremity, plate 4) is a short trunk about one inch in length, and of considerable size. It rises immediately below the tuberosity of the radius, and divides into two branches, the anterior and posterior interosseous. The anterior interosseous artery passes down the forearm on the anterior surface of the interosseous membrane, accompanied by the interosseous branch of the median nerve, then down behind the pronator quadratus, and anastomoses with the posterior interosseous artery. The posterior interosseous artery passes backward through the interval between the oblique ligament and the upper border of the interosseous membrane; descending to the wrist, it anastomoses with the termination of the anterior interosseous, and with the posterior carpal branches of the radial and ulnar arteries. Near its origin it gives off the interosseous recurrent branch. The muscular branches are distributed through the muscles along the ulnar side of the forearm. The carpal branches (1, plate 4, Upper Extremity) supply the wrist joint. Of these, the anterior carpal is a small vessel which crosses the front of the carpus and inosculates with a corresponding branch of the radial artery; the posterior carpal arises immediately above the pisiform bone, and winds backward beneath the tendon of the flexor carpi ulnaris. It anastomoses with a corresponding branch of the radial artery, and, forming the posterior carpal arch immediately after its origin, it gives off a small branch which runs along the ulnar side of the metacarpal

bone of the little finger, forming one of the metacarpal arteries and supplying the ulnar side of the dorsal surface of the little finger. The deep or communicating branch arises at the commencement of the palmar arch, anastomoses with the termination of the radial artery, and thus completes the deep palmar arch. The digital branches (lower part plate 5, Upper Extremity) are four in number, and are given off from the convexity of the superficial palmar arch. They supply the ulnar side of the little finger, and the adjoining sides of the four fingers, the radial side of the index finger and thumb being supplied from the radial artery. The digital arteries are at first superficial; but, as they pass forward to the clefts between the fingers, they lie between them, and are there joined by the interosseous branches from the deep palmar arch. The digital arteries on the sides of the fingers lie beneath the digital nerves, and, about the middle of the last phalanx, the two branches for each finger form an arch.

The descending aorta (4, Blood Formation) is divided into two portions, the *thoracic* (6, Blood Formation) and the *abdominal* aorta (a, back plate Body), in correspondence with the two great cavities of the trunk, in which it is situated. The thoracic aorta (6, Blood Formation) commences at the lower border of the fifth dorsal vertebra on the left side, and terminates at the aortic opening in the diaphragm, in front of the last dorsal vertebra. At its commencement, it is situated on the left side of the spine, approaches the median line as it descends, and at its termination lies directly in front of the column. As its branches are small, the diminution in the size of the vessel is inconsiderable. In front it is in relation from above downward with the left pulmonary artery (5, Blood Forma-

tion), behind with the vertebral column and the vena azygos minor, on the right side with the vena azygos major and the thoracic duct (29, Blood Formation), on the left side with the pleura and lung.

The branches of the thoracic aorta (6, Blood Formation) are the *pericardiac*, the *bronchial*, the *œsophageal*, the *posterior mediastinal*, and the *intercostal*. The pericardiac arteries are a few small vessels irregular in their origin and distributed to the pericardium. The bronchial arteries are the nutrient vessels of the lungs, and vary in number, size and origin; that of the right side rises from the first aortic intercostal, or by a common trunk with the left bronchial, from the front of the thoracic aorta; those of the left side, usually two in number, rise from the thoracic aorta, one a little lower than the other. The œsophageal arteries, usually five in number, rise from the front of the aorta, and pass downward to the œsophagus, anastomosing with the œsophageal branches of the inferior thyroid arteries above, and with ascending branches from the phrenic and gastric arteries below. The posterior mediastinal arteries are many but small vessels which supply the glands and loose areolar tissue in the mediastinum. The intercostal arteries, of which there are usually ten pairs, rise from the back part of the aorta, and lie on each side of the superior intercostal space. The right arteries are longer than the left, and, on account of the position of the aorta on the left side of the spine, they pass outward across the bodies of the vertebræ to the intercostal spaces, being covered by the pleura, the œsophagus, the thoracic duct and vena azygos major. The left pass beneath the superior intercostal vein, the azygos vein, the vena azygos minor and sympathetic. In the intercostal spaces, each artery divides into two branches, an anterior and a poste-

rior branch. The anterior branch passes outward, then between the two layers of intercostal muscles, and, having ascended to the lower border of the rib above, divides near the angle of that bone into two branches. Of these, the larger runs in the groove on the lower border of the rib above; the smaller, along the upper border of the rib below. As they pass forward, they supply the intercostal muscles, and anastomose with the anterior intercostal branches of the internal mammary and with the thoracic branches of the axillary artery. The first aortic intercostal artery anastomoses with the superior intercostal, and the last three pass between the abdominal muscles, inosculating with the epigastric in front, and with the lumbar arteries. Each intercostal artery is accompanied by a vein and nerve, the former above, the latter below, and are protected from pressure during the action of the intercostal muscles by fibrous arches thrown across and attached by each extremity to the bone. The posterior branch of each intercostal artery passes backward to the inner side of the anterior costo-transverse ligament, and divides into a spinal branch, which supplies the vertebræ, the spinal cord and its membranes.

The abdominal aorta (A, last plate Body) commences at the aortic opening of the diaphragm in front of the body of the last dorsal vertebra, and, descending a little to the left side of the vertebral column, terminates on the body of the fourth lumbar vertebra, generally to the left of the median line, where it divides into the two common iliac arteries (F, last plate Body). It diminishes in size very rapidly in consequence of the many large branches which it gives off. It is covered in front by the stomach, behind which are the branches of the cœliac axis and the solar plexus, and below these by the splenic vein (21, Blood

Formation), the pancreas (19, last plate Body), the left renal vein (W, last plate Body), the transverse portion of the duodenum, the mesentery and the aortic plexus. Behind, it is separated from the lumbar vertebra by the left lumbar veins (A, last plate Body) and thoracic duct (29, Blood Formation). On the right side it is in relation with the inferior vena cava (E, last plate Body); on the left with the sympathetic nerve and left semilunar ganglion. The single branches of the abdominal aorta (A, last plate Body) are the *cœliac axis* (7, Blood Formation), the *superior mesenteric* and the *inferior mesenteric* (Y, last plate Body).

The cœliac axis (see Blood Formation) is a short, thick trunk about one-half inch in length, which arises from the aorta opposite the margin of the diaphragm, and, passing horizontally forward, divides into three large arteries — the *gastric* (7), the *hepatic* (8), and the *splenic* (9), and occasionally giving off one of the *phrenic* arteries. It is covered by the lesser omentum on the right side, is in relation with the right semilunar ganglion and the lobus Spigelii; on the left side with the left semilunar ganglion and cardiac end of the stomach, and below rests on the upper border of the pancreas. The gastric artery (7, Blood Formation), the smallest of the three branches of the cœliac axis, passes up and to the left side to the cardiac orifice of the stomach, distributing branches to the œsophagus, which anastomose with the aortic œsophageal arteries, and others which supply the cardiac end of the stomach, inosculating with branches of the splenic artery. It then passes from left to right along the lesser curvature of the stomach to the pylorus, and at its termination anastomoses with the pyloric branch of the hepatic artery. The hepatic artery (8, Blood Formation) is intermediate

in size between the gastric and splenic arteries. It is first directed forward and to the right, to the upper margin of the pyloric orifice of the stomach, forming the lower boundary of the foramen of Winslow, then passes upward between the layers of the lesser omentum and in front of the foramen of Winslow to the transverse fissure of the liver, where it divides into two branches — right and left — which supply the corresponding lobes of that organ. This artery, in its course along the right border of the lesser omentum, is in relation with the portal veins. The cystic artery, a branch of the hepatic, passes upward along the neck of the gall-bladder, and divides into two branches, one of which ramifies on its free surface, the other between it and the substance of the liver. The splenic artery (9, Blood Formation) is the largest of the three branches of the cœliac axis, and is very tortuous in its course. Accompanied by the splenic vein, which lies below, it passes along the left side of the upper border of the pancreas, and, on arriving near the spleen, divides into branches, some of which are distributed to the great end of the stomach, and others, the pancreatic, to the pancreas.

The superior mesenteric artery (11, Blood Formation) supplies, with the exception of the first part of the duodenum, the whole length of the small intestine, the cæcum, and ascending and transverse colon. It is a very large vessel arising from the fore part of the aorta about one-fourth inch below the cœliac axis, being covered at its origin by the splenic vein (21, Blood Formation) and pancreas. It passes forward between the transverse portion of the pancreas and duodenum, crosses in front of this portion of the intestine, and descends between the layers of the mesentery to the right iliac fossa, where,

diminished in size, it terminates. In its course it forms an arch, is accompanied by the superior mesenteric vein and has five branches. The inferior pancreatico-duodenal branch is given off behind the pancreas, and anastomoses with the superior pancreatico-duodenal artery; the ileo-colic is the lowest branch given off from the concavity of the artery; the colica dextra branch arises from about the middle of the concavity of the artery, and, passing beneath the peritoneum to the middle of the ascending colon, divides into two branches, one descending and one ascending; the colica media branch arises from the upper part of the concavity of the artery, and, passing forward between the layers of the transverse meso-colon, divides into two branches — the one on the right side inosculating with the colica dextra, and that on the left with the colica sinistra, a branch of the inferior mesenteric.

The inferior mesenteric artery (Y, last plate Body) supplies the descending and sigmoid flexure of the colon (14, Stomach plate) and the greater part of the rectum. It is smaller than the superior mesenteric, and arises from the left side of the aorta between one and two inches above its division into the common iliacs, passes downward to the left iliac fossa, and then descends, under the name of the superior hæmorrhoidal arteries, between the layers of the meso-rectum into the pelvis. It lies at first in close relation with the left side of the aorta, and then passes, as the superior hæmorrhoidal artery, in front of the left common iliac artery, dividing into the *colica sinistra*, *sigmoid* and *superior hæmorrhoidal* branches. Of these the colica sinistra passes behind the peritoneum in front of the left kidney to reach the descending colon, and divides into an ascending and descending branch; the sigmoid artery runs downward across the psoas muscle to the sigmoid flexure

of the colon, and divides into branches which supply that part of the intestine, anastomosing above with the colica sinistra, and below with the superior hæmorrhoidal branches; the superior hæmorrhoidal ascends into the pelvis, crossing in its course the ureter and left common iliac vessels, dividing, opposite the middle of the sacrum, into two branches, which descend one on each side of the rectum, where they divide into several small branches, which are distributed between the mucous and muscular coats of that tube nearly as far as its lower end, anastomosing with each other, with the middle hæmorrhoidal artery, and branches of the internal iliac artery.

The supra-renal arteries are two small vessels rising one on each side of the aorta, opposite the superior mesenteric artery, and passing upward to the under surface of the supra-renal capsules, to which they are distributed. They anastomose with capsular branches from the phrenic and renal arteries, and in the adult are of small size.

The renal arteries (V, last plate Body) are two large trunks which rise from the sides of the aorta immediately below the superior mesenteric artery, each directed outward so as to form nearly a right angle with that vessel. Previous to entering the kidney, each artery divides into four or five branches which are distributed to its substance.

The spermatic arteries (X, last plate Body) distributed to the testes in the male, and the ovaria in the female, are two slender vessels of considerable length which arise from the front of the aorta just below the renal arteries. On reaching the margin of the pelvis (22, last plate Body) each vessel passes in front of the corresponding iliac artery, in the male being directed outward to the internal abdominal ring, and accompanying the other constituents of the sper-

matic cord (18, Male Genital Organs), along the spermatic canal to the testes (20, Male Genital Organs), where it divides into several branches. In the female, the spermatic arteries (X, last plate Body) are shorter than in the male, and do not pass out of the abdominal cavity, but, on arriving at the margin of the pelvis (22, last plate Body), each artery passes inward between the two laminæ of the broad ligament of the uterus (U, Female Genital Organs) to be distributed to the ovary (O, Female Genital Organs), one or two small branches supplying the Fallopian tube (F, T, Female Genital Organs), another passing on to the side of the uterus and anastomosing with the uterine arteries.

The phrenic arteries are two small vessels which present a great deal of variety in their origin. They may arise separately from the front of the aorta immediately above the cœliac axis, or by a common trunk which may spring from the aorta or from the cœliac axis, or sometimes one is derived from the aorta and the other from one of the renal arteries. They diverge from one another across the crura of the diaphragm, and then pass obliquely upward and outward upon its under surface, the left passing behind the œsophagus, and running forward on the left side of the œsophageal opening, the right passing behind the interior vena cava, and ascending along the right side of the aperture for transmitting that vein.

Near the back part of the central tendon each vessel divides into two branches, the internal branch running forward to the front of the thorax, supplying the diaphragm, and anastomosing with its fellow of the opposite side and with the musculo-phrenic branches of the internal mammary (Breast), the external branch passing the side of the thorax and inosculating with the intercostal arteries. The

internal branch of the right phrenic gives off a few vessels to the inferior vena cava, the left, some branches to the œsophagus, and each vessel sends capsular branches to the supra-renal capsule of its own side, the spleen and the liver.

The lumbar arteries (V, last plate Body), usually four pairs, are analogous to the intercostal, and rise from the back of the aorta nearly at right angles with that vessel. They pass out and back around the sides of the body of the lumbar vertebræ, those on the right being covered by the inferior vena cava (E, last plate Body), and the two upper ones on each side by the crura of the diaphragm. In the interval between the transverse processes of the vertebræ, each artery divides into a dorsal and abdominal branch. The dorsal branch gives off, immediately after its origin, a spinal branch, which enters the spinal canal, continues on its course backward between the transverse processes, and is distributed to the muscles and integument of the back, anastomosing with the similar branches of the adjacent lumbar arteries and with the intercostal branches. It also divides into two branches, one of which ascends on the posterior surface of the body of the vertebræ above, and the other descends on the posterior surface of the vertebræ below. The inosculations of these vessels on each side throughout the whole length of the spine, form a series of arterial arches behind the bodies of the vertebræ, which are connected with each other and with a median longitudinal vessel. The abdominal branches pass outward behind the quadratus lumborum, the lowest branch occasionally in front of that vessel, and, being continued between the abdominal muscles, anastomose with branches of the epigastric and internal mammary in front, the intercostals above, and those of the ilio-lumbar and circumflex iliac below.

The middle sacral artery is a small vessel about the size of a common quill, which arises from the back of the aorta just at its bifurcation, descends at the last lumbar vertebra and along the middle line of the front of the sacrum to the upper part of the coccyx, where it anastomoses with the lateral sacral arteries, and terminates in a middle branch, which runs down to that portion of the body described as Luschka's gland. Other branches are given off on each side which anastomose with the lateral sacral arteries. Luschka's gland lies near the tip of the coccyx, just above the coccygeal attachment of the sphincter, and consists of a congeries of small arteries derived from the middle sacral and freely communicating with each other.

The abdominal aorta divides into the two common iliac arteries ( G, last plate body ), the bifurcations usually taking place on the left side of the body of the fourth lumbar vertebra, a point corresponding to the left side of the umbilicus (white spot, last plate of Body), and on a level with a line drawn from the highest point of one iliac crest to the other. The common iliac arteries are about two inches in length, diverge from the termination of the aorta, pass downward and outward to the margin of the pelvis, and divide, opposite the intervertebral substance between the last lumbar vertebra and the sacrum, into two branches, the external and the internal iliac arteries, the former supplying the lower extremity, the latter the viscera, and parietes of the pelvis. The right common iliac is somewhat larger than the left, and passes more obliquely across the body of the last lumbar vertebra; in front of it are the peritoneum, the ilium, branches of the sympathetic nerve, and at its point of division, the ureter; while behind it is separated from

the last lumbar vertebra by the two common iliac veins, and on its outer side it is in relation with the interior vena cava, the right common iliac vein above, and the psoas magnus muscle below. The left common iliac is in relation in front with the peritoneum, branches of the sympathetic nerve, and the superior hæmorrhoidal artery, and is crossed at its point of bifurcation by the ureter (24, last plate Body). The common iliac arteries give off small branches to the peritoneum, psoas magnus, ureters, and the surrounding cellular tissue, and occasionally give origin to the renal arteries. The internal iliac artery supplies the walls and viscera of the pelvis (22, back plate Body), the generative organs, and the inner part of the thigh. It is a short, thick vessel, about an inch and a half in length, rising at the point of bifurcation of the common iliac, passing downward to the upper margin of the great sacro-sciatic foramen, and dividing into two large trunks. The internal iliac has twelve branches, a few of which it is necessary to mention. These are the *uterine* artery, or the artery of the womb, the *vaginal* artery, and a few arteries common to both sexes. The uterine artery passes downward from the anterior trunk of the internal iliac to the neck of the uterus, ascending in a tortuous course on the side of the viscera; between the layers of the broad ligament it distributes branches to its substance, anastomosing near its termination with a branch from the ovarian artery, and branches from this vessel are also distributed to the bladder and ureter. The vaginal artery is analogous to the inferior vesical in the male, descends upon the vagina, supplying its mucous membrane, and sends branches to the neck of the bladder and contiguous parts of the rectum.

The obturator artery (last plate Body) usually arises

from the anterior trunk of the internal iliac, passes forward below the brim of the pelvis to the canal in the upper border of the obturator foramen, and, escaping from the pelvic cavity through this aperture, divides into an internal and an external branch. In the pelvic cavity this vessel lies upon the pelvic fascia, beneath the peritoneum, and a little below the obturator nerve, and, while passing through the obturator foramen, is contained in a canal formed by the horizontal branch of the pubes above, and the border of the obturator membrane below. Within the pelvis, the obturator artery gives off a branch of the iliac to the iliac fossa, which anastomoses with the ilio-lumbar artery, a vesical branch, which supplies the bladder, and pubic branch, which is given off before it leaves the pelvic cavity. External to the pelvis, the obturator artery divides into an external and an internal branch, which are both deeply seated beneath the obturator externus muscle, and which anastomose at the lower part of this aperture with each other, and with branches of the internal circumflex artery. The internal branch curves downward along the inner margin of the obturator foramen, distributes branches to three or four muscles, and anastomoses with the external branch and internal circumflex artery; the external branch curves around the outer margin of the foramen obturator to the space between the gemellus inferior and quadratus femoris, where it anastomoses with the sciatic artery, as it passes backward with the internal circumflex; it also sends a branch to the hip joint.

The internal pudic is the smallest of the two terminal branches of the anterior trunk of the internal iliac, and supplies the external organs of generation; it divides finally into two terminal branches, the dorsal artery of the penis and the artery of the corpus cavernosum. It is

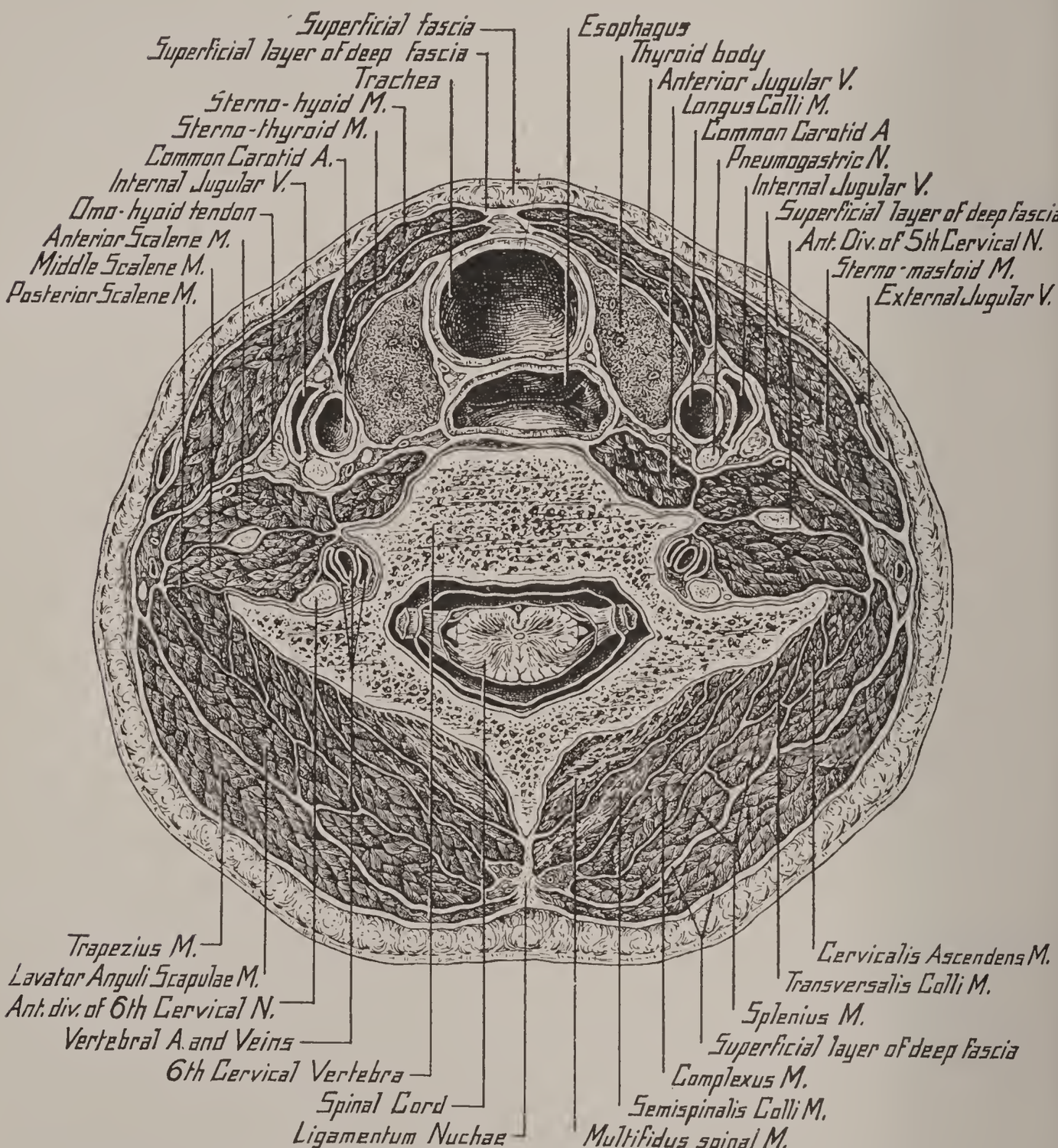
accompanied by the pudic veins and nerve. The dorsal artery of the penis ascends between the crus and pubic symphysis, runs forward on the dorsum of the penis to the glans, where it divides into two branches which supply the glans and prepuce. On the dorsum of the penis it lies immediately beneath the integument parallel with the dorsal vein and the corresponding artery of the opposite side.

The sciatic artery, the larger of the two terminal branches of the anterior trunk of the internal iliac, is distributed to the muscles on the back of the pelvis, passes down to the lower parts of the great sacro-sciatic foramen, behind the internal pudic, then descends in the interval between the trochanter major and the tuberosity of the ischium.

The gluteal artery (B, last plate Body) is the largest branch of the internal iliac, and appears to be the continuation of the posterior division of that vessel. It is a short, thick trunk which passes out of the pelvis above the upper border of the pyriformis muscle, and immediately divides into a superficial and deep branch; just before it leaves the cavity of the pelvis it gives off a nutrient artery which enters the ilium. The superficial branch passes beneath the gluteus maximus and divides into many branches. The deep branch runs between the gluteus medius and minimus, and subdivides into the superior and inferior division; the former continues the original course of the vessel, and anastomoses with the cimcumflex iliac and ascending branches of the external circumflex artery; the latter crosses the gluteus minimus obliquely to the trochanter major, and inosculates with the circumflex artery.

The external iliac artery is the chief vessel which sup-

A Few of the Parts from a Human Subject in twenty Dissections, showir the exact positions of the Arteries, Veins, Nerves and Muscles throughout the huma body, also the organs of the Thoracic and Abdominal Cavities in their normal place




TRANSVERSE SECTION OF THE NECK IN REGION WHERE THE CAROTID ARTERIES ARE RAISED.

plies the lower limb. It is larger than the internal iliac, and passes downward and outward along the inner border of the psoas muscle from the bifurcation of the common iliac to Poupart's ligament (31, Muscle plate), where it enters the thigh and becomes the femoral artery. At its origin it is crossed by the ureter, and numerous lymphatic vessels are found lying on its front and inner side. Besides several small branches, the external iliac gives off two branches of considerable size, the *deep epigastric* and *deep circumflex iliac.*

The deep epigastric artery arises from the external iliac a few lines above Poupart's ligament, at first descends to reach this ligament, then ascends along the inner margin of the internal abdominal ring, and finally divides into numerous branches which anastomose above the umbilicus with the terminal branches of the internal mammary and inferior intercostal arteries. The deep circumflex artery rises from the outer side of the external iliac, nearly opposite the epigastric artery, ascends obliquely upward behind Poupart's ligament, runs along the inner surface of the crest of the ilium to about its middle, where it pierces the transversalis, and runs backward between that muscle and the internal oblique to anastomose with the iliac, lumbar and gluteal arteries. Opposite the anterior superior spine of the ilium it gives off a large branch, which ascends between the internal oblique and transversalis muscle, supplying them, anastomosing with the lumbar and epigastric arteries.

The femoral artery (A, plate 3, Lower Extremity), the continuation of the external iliac, commences immediately behind Poupart's ligament, midway between the anterior superior spine of the ilium, and the symphysis pubis, and, passing down the fore part and inner side of the thigh,

terminates at the opening in the adductor magnus at the junction of the middle with the lower third of the thigh, where it becomes the popliteal artery. The upper two-thirds of a line drawn from a point midway between the anterior superior spine of the ilium and the spine of the pubis to the inner side of the inner condyle of the femur, with the thigh abducted and rotated so that the foot stands outward, will indicate the course of this artery.

In the upper third of the thigh, the femoral artery is very superficial, and is contained in a triangular space called Scarpa's triangle, which corresponds to the depression seen immediately below the groin fold. The apex of the triangle is directed downward, the sides formed externally by the sartorius muscle, internally by the adductor longus, and above by Poupart's ligament. The floor of this space is formed by the *iliacus*, *psoas*, *pectineus*, *adductor longus*, and a small part of the *adductor brevis muscle*. It is divided into two nearly equal parts by the femoral vessels, which extend from the middle of its base to its apex. The artery in this situation gives off its cutaneous and profunda branches. The branches of the femoral artery are the *superficial epigastric*, *superficial circumflex iliac*, *superficial external pudic*, the *deep external pudic*, and the several *profunda* branches — namely the *external circumflex*, *internal circumflex*, and three *perforating*.

The superior epigastric rises from the femoral about one-half an inch below Poupart's ligament, and, passing through the saphenous opening in the fascia lata, ascends to the abdomen and anastomoses with branches of the deep epigastric and internal mammary arteries; the superficial circumflex iliac (D, back plate Body), the smallest of the cutaneous branches, rises close to the preceding branch, runs outward parallel with Poupart's ligament as

far as the crest of the ilium, and there divides into branches, supplying the fascia and the inguinal glands, and anastomosing with the circumflex iliac (B, back plate Body) and with the gluteal and external circumflex artery; the superficial external pudic rises from the inner side of the femoral artery close to the preceding vessels, and, after passing through the saphenous opening, courses inward across the spermatic cord, to be distributed to the integument on the lower part of the abdomen, the penis and scrotum in the male, and the labium in the female, anastomosing with the branches of the internal pudic; the deep external pudic passes inward on the pectineus muscle, and, covered by the fascia lata, its branches are distributed in the male to the integument of the scrotum and perineum, and in the female to the labium, anastomosing with branches of the superficial perineal artery. The profunda femoris (B, plate 3, Lower Extremity) nearly equal in size to the superficial femoral, rises from the outer and back part of the femoral artery, a little below Poupart's ligament. Lying on the outer side of the superficial femoral, and then passing behind it and the femoral vein to the inner side of the thigh bone, it terminates in a small branch in the lower third of the thigh. The external circumflex artery (L, back plate Body) supplies the muscles on the front of the thigh, and, rising from the outer side of the profunda, passes outward in a horizontal direction, and divides into three sets of branches — *ascending*, *transverse*, and *descending*. The internal circumflex artery (F, back plate Body) rises from the inner and back part of the profunda, and winds around the inner side of the femur. On reaching the upper border of the adductor brevis, it gives off two branches, one of which passes inward, anastomosing with the obturator artery;

the other descends and passes beneath the adductor brevis to supply it and the great adductor, while the continuation of the vessel passes backward between the quadratus femoris and upper border of the adductor magnus, anastomosing with the sciatic external circumflex, and superior perforating arteries. The perforating arteries, usually three in number, are so called from their perforating tendons of the adductor brevis and magnus muscle.

The popliteal artery (F, plate 6, Upper Extremity) commences at the termination of the femoral, at the opening in the adductor magnus, and, passing downward and outward behind the knee joint to the lower border of the popliteal muscle, divides into the *anterior* and *posterior tibial* arteries (G, lower part plate 5, Lower Extremity), and through the whole of its extent lies in the popliteal space.

The popliteal space (H, plate 5, Lower Extremity) occupies the lower third of the thigh and the upper fifth of the leg, extending from the aperture in the adductor magnus to the lower part of the popliteal muscle; it is shaped like a lozenge, being widest at the back part of the knee joint, and deepest above the articular end of the femur. Its floor is formed by the lower part of the posterior surface of the shaft of the femur, the posterior ligament of the knee joint, the upper end of the tibia, and the fascia covering the popliteal muscle; the space is covered in by the fascia lata. It contains the popliteal vessels and their branches, the termination of the external saphenous vein, the internal and external popliteal nerves and their branches, the small sciatic nerve, a few small lymphatic glands and a quantity of tissue.

There are many branches given off by the popliteal artery, of which we will mention but three; the *cutaneous*

*branches* (f, plate 6, Lower Extremity), the *superior articular arteries* and the *inferior articular arteries*. The cutaneous branches descend on each side, and in the middle of the limb rise separately from the popliteal artery and supply the integument of the calf of the leg. The superior articular arteries (plate 4, Lower Extremity) are two in number, and rise one on each side of the popliteal, and wind around the femur, immediately above its condyles, to the front of the knee joint; the superficial branch supplies the vastus externus, and anastomoses with a descending branch of the external circumflex artery. The inferior articular arteries (plate 4, Lower Extremity) are also two in number, and rise from the popliteal beneath the gastrocnemius, and wind around the head of the tibia (1, lower part plate 5, Lower Extremity) below the joint, the internal branch passes below the inner tuberosity, beneath the internal lateral ligament, at the anterior border of which it ascends to the front and inner side of the joint to supply the head of the tibia and the articulation of the knee; the external branch passes outward above the head of the fibula to the front of the knee joint, and divides into branches which anastomose with the inferior internal articular artery, the superior articular arteries, and the recurrent branch of the anterior tibial.

The anterior tibial artery (Q, plate 5, Lower Extremity) commences at the bifurcation of the popliteal at the lower border of the popliteus muscle, passes forward between the two heads of the tibialis posticus, and through the aperture left between the bones at the upper part of the interosseous membrane to the deep part of the front of the leg; it then descends on the anterior surface of the tibia to the bend of the ankle joint, where it lies more superficially and becomes the dorsalis pedis. A line drawn from the inner

side of the head of the fibula to midway between the two malleoli will mark the course of the artery, the point where it comes in front of the interosseous membrane being in this line one and a quarter inches below the level of the head of the fibula. Or, if the foot is turned so as to loosen the muscles, the artery is then exposed deeply seated.

The branches of the anterior tibial artery are the *recurrent tibial* (B, lower part plate 5, Lower Extremity), *muscular*, *internal malleolar*, and *external malleolar*. The recurrent branch rises from the anterior tibial as soon as that vessel has passed through the interosseous space, and anastomoses with the articular branches of the popliteal artery; the muscular branches are many, and are distributed to the muscles which lie on either side of the vessel, many of them anastomosing with the branches of the posterior tibial and peroneal arteries (H, lower part plate 5, Lower Extremity); the malleolar branches supply the ankle joint, the internal rising about two inches above the articulation, and passing beneath the tendons of the extensor proprius pollicis and tibialis anticus, to the inner ankle, upon which it ramifies, anastomosing with branches of the posterior tibial and internal plantar arteries (L, lower part plate 5, Lower Extremity); the external passes beneath the tendons of the extensor longus digitorum and peroneus tertius, and supplies the outer ankle, anastomosing with the anterior peroneal arteries.

The dorsalis pedis artery (A, lower part plate 5, Lower Extremity), the continuation of the anterior tibial, passes forward from the bend of the ankle, along the foot to the back of the first interosseous space, where it divides in two branches. This vessel in its course forward rests upon the astragalus, scaphoid and internal cuneiform bones, and is covered by the fascia; on its fibular side is the termination

of the anterior tibial nerve, and it is accompanied by two veins. The branches of the dorsalis pedis artery are the *tarsal* (D, lower part plate 5, Lower Extremity), the *metatarsal* (E, lower part plate 5, Lower Extremity), the *interosseous*, the *dorsalis hallucis*, and the *communicating*. The tarsal artery rises from the dorsalis pedis, as that vessel crosses the scaphoid bone, passes in an arched direction outward, and, lying upon the tarsal bone, it anastomoses with branches from the metatarsal, external malleolar and external plantar arteries; the metatarsal rises a little in front of the preceding, passes outward to the outer part of the foot over the bases of the metatarsal bones, and anastomoses with the tarsal and external plantar arteries (M, lower part plate 5, Lower Extremity). The outermost interosseous artery gives off a branch which supplies the outer side of the little toe. The dorsalis hallucis (F, lower plate 5, Lower Extremity) runs forward along the outer border of the first metatarsal bone, at the cleft between the first and second toes divides into two branches, one of which passes inward and is distributed to the inner border of the great toe, the other branch bifurcates to supply the adjoining sides of the great and second toes; the communicating artery dips down into the sole of the foot and inosculates with the termination of the external plantar artery to complete the plantar arch; it here gives off two digital branches, one running along the inner side of the great toe on its plantar surface, the other passing forward along the first metatarsal space, where it bifurcates to supply the adjacent sides of the great and second toes.

The posterior tibial artery (G, lower part plate 5, Lower Extremity) is of large size, and extends obliquely downward from the lower border of the popliteus muscle, along the tibial side of the leg, to the inner ankle and

heel, where it divides beneath the origin of the abductor pollicis into the internal and external plantar arteries. At its origin it lies opposite the interval between the tibia (1, plate 5) and fibula (4, plate 5), and, as it descends, approaches the inner side of the leg, lying behind the tibia. In the lower part of its course, it is situated midway between the inner malleolus (3, plate 5) and the os calcis. It is more superficial at its lower third, being covered by the integument and fascia only, and runs parallel with the tendo Achillis. It is accompanied by two veins and by the tibial nerve, which in the greater part of its course is situated on its outer side.

## VEINS.

(Plate, Blood Formation.)

The veins are the vessels which serve to convey the blood from the capillaries of the different parts of the body to the heart, and, like the arteries, they are found in nearly all the tissues of the body. They commence by minute plexuses which receive the blood from the capillaries, communicate freely with each other, and in form are not cylindrical, as are the arteries, their walls being thinner, and collapsed when they are empty. They are larger and more numerous than the arteries, and, with the exception of the pulmonary veins (17), which do not in capacity exceed the pulmonary arteries (5), the entire capacity of the venous system is decidedly greater than the arterial.

Like the arteries, the veins consist of two separate and distinct systems, the pulmonary and systemic. The pulmonary veins, unlike other vessels of this kind, contain arterial blood, which they return from the lungs to the left auricle (26) of the heart. The systemic veins are con-

cerned in the general circulation, and return the venous blood from the body to the right auricle (25) of the heart. The portal vein (23), an appendage to the systemic venous system, is confined to the abdominal cavity, returning venous blood from the viscera of digestion, and carrying it to the liver (32) by a single trunk of extra size, the vena porta (23). This vessel ramifies in the substance of the liver, and breaks up into a minute network of capillaries, which then reunite to form the hepatic veins (19), by which the blood is conveyed to the inferior vena cava (18).

The systemic veins are subdivided into three sets, *i.e.*, the *superficial* or *subcutaneous* veins, the *deep* veins and the *sinuses*. The superficial veins are found immediately beneath the integument, between the layers of the superficial fascia, and communicate with the deep veins by perforating the deep fascia. The deep veins have thinner coats, always accompany the arteries, and are usually in the same sheath. The larger arteries have usually but one accompanying vein; but in the smaller arteries they exist in pairs, lying on each side of the artery, and are called the venæ comites. Sinuses are venous channels which differ entirely from the veins. In the lower limbs the veins are much thicker than in the upper.

### THE PULMONARY VEINS.

(See Plate, Blood Formation.)

There are four pulmonary veins (17), each lung having two, and their office is to convey the arterial blood from the lungs to the left auricle (26) of the heart. They differ from other veins in many respects; first, they carry arterial instead of venous blood; second, they have no valves; third, they are only slightly larger than the arteries,

which they accompany; fourth they accompany those arteries singly. They commence in the capillary network upon the walls of the air-cells, where they are continuous with the ramifications of the pulmonary artery (5), and, uniting together, they form a single trunk for each lobule. Within the lung, the pulmonary artery (5) branches are in front, the veins behind, and the bronchi between the two; at the root of the lung, the veins are in front, the artery in the middle, and the bronchi behind.

## THE SYSTEMIC VEINS.

The systemic veins may be arranged into three groups: First, those of the head, neck, upper extremities, and thorax; second, those of the lower extremities, pelvis, and abdomen, which terminate in the inferior vena cava (18); third, the cardiac veins, which open directly into the right auricle (25) of the heart.

The veins of the head and neck (see Head plate) may be subdivided into three groups: first, those of the exterior of the head; second, those of the neck; third, those of the diploë and interior of the cranium.

The veins of the exterior of the head are the *facial*, (17, Head plate), the *temporal* (18), the *internal maxillary* (35), the *temporo-maxillary*, the *posterior-auricular*, and the *occipital*. The facial vein (17) crosses obliquely the side of the face, is on the outer side of the facial artery (20), and is not so tortuous as that vessel. The frontal vein commences on the anterior portion of the skull by a venous plexus, and communicates with the anterior tributaries of the temporal vein (18); occasionally the frontal veins join to form a single trunk, which bifurcates or branches at the root of the nose into the two angular veins. The temporal vein commences by a minute plexus

on the side of the skull, and communicates with the frontal vein in front. The internal maxillary vein is quite large, and receives branches which correspond with branches of the internal maxillary artery; it receives several small veins, together forming a plexus of large size, which communicates very freely with the facial vein (17). The temporo-maxillary vein is formed by the union of the temporal (18) and internal maxillary vein (35). It descends in the substance of the parotid gland, on the outer surface of the external carotid artery (1, Blood Formation), between the jaw and the sterno-mastoid muscle, and divides into two branches; one passes inward and joins the facial vein (17), the other is joined by the posterior auricular vein and becomes the external jugular (16, Blood Formation). The posterior auricular vein commences on the side of the head by a plexus, which communicates with the tributaries of the temporal and occipital veins; it descends behind the ear, and joins the temporo-maxillary vein, thus forming the external jugular vein. The occipital veins are three in number. They commence at the back part of the skull by a plexus, follow the course of the occipital artery, and usually terminate in the internal jugular vein, though sometimes their termination is found in the external jugular vein.

The veins of the neck, which return the blood from the head and face, are the *external jugular* (16, Head plate), the *anterior jugular*, the *posterior external jugular*, the *internal jugular* and the *vertebral* vein. The external jugular vein receives the greater part of the blood from the exterior of the cranium and deep parts of the face. It commences in the substance of the parotid gland, on a level with the angle of the lower jaw, and runs perpendicularly down the neck in the direction of a line drawn from

the angle of the jaw to the middle of the clavicle (13, Skeleton plate). It then crosses the sterno-mastoid muscle, and runs parallel with its posterior border as far as its attachment to the clavicle, where it perforates the deep fascia and terminates in the subclavian vein (15, Blood Formation). The external jugular vein varies in size, and is sometimes found double. It has two pairs of valves, the lower situated at its entrance into the subclavian vein, the upper about one or two inches above the clavicle. These valves do not prevent the regurgitation of the blood or the passage of an injection from below upward. The posterior external jugular vein returns the blood from the integument and superficial muscles in the upper and back part of the neck; it runs down the back part of the neck, and opens into the external jugular vein just below the middle of its course. The anterior jugular vein, or veins, for most frequently there are two, commence near the hyoid bone (19, Body plate), and pass down between the median line and the anterior border of the sterno-mastoid (18, Body plate). These veins vary extremely in size, and communicate with the jugular veins. They have no valves, and consequently can be injected. The internal jugular vein collects the blood from the interior of the cranium, from the superficial parts of the face, and also from the neck. It commences just externally to the jugular foramen, in the base of the skull, runs down the side of the neck in a vertical direction, lying at first on the outer side of the internal carotid, and then on the outer side of the common carotid arteries (19, Head plate). At the root of the neck it unites with the subclavian vein to form the vena innominata (14, Blood Formation); this vein is sometimes quite large, and is provided with one pair of valves, which usually are at its termination, though sometimes

they are placed a little above. The vertebral vein commences in the occipital region by numerous small tributaries from the deep muscles at the upper and back part of the neck, passes outward and enters the foramen in the transverse process of the atlas; descends by the side of the vertebral artery in the canal formed by the transverse processes of the cervical vertebræ, emerges from the foramen in the transverse processes of the six cervical vertebræ, and terminates at the root of the neck in the back part of the innominate vein (14, Blood Formation). Near its origin its mouth is guarded by one pair of valves. On the right side it crosses the first part of the subclavian artery (3, Blood Formation).

### THE SUPERFICIAL VEINS OF THE UPPER EXTREMITY.

(See plate, Upper and Lower Extremities.)

The superficial veins are placed immediately beneath the integument between the two layers of superficial fascia, and commence in the hand, chiefly on its dorsal aspect, where they form a more or less complete arch. They are, namely, the *anterior ulnar*, *posterior ulnar*, *radial*, *median*, *median basilic*, *median cephalic basilic*, and *cephalic*.

The anterior ulnar vein commences on the anterior surface of the ulnar side of the hand and wrist, and continues its course along the inner or ulnar side of the forearm to the bend of the elbow, where it joins with the posterior ulnar vein to form the basilic; occasionally, it opens in the median basilic vein. The posterior ulnar vein commences on the posterior surface of the ulnar side of the hand, and from the vein of the little finger (the vena salvatella), it runs on the posterior surface on the ulnar side of the forearm, and, just below the elbow, unites with the anterior ulnar

vein to form the basilic vein. Sometimes it joins the median basilic (5) to form the basilic vein, (II.) and it also communicates by a branch with the deep veins of the palm. The common ulnar vein is a short trunk which is not constant; when it does exist, it is formed by the junction of the two preceding veins. The radial vein (III.) commences from the dorsal surface of the thumb, index finger, and radial side of the hand, communicates with the vena salvatella and with the deep veins of the palm by a branch which passes through the first interosseous space; at the bend of the elbow it unites with the median cephalic to form the cephalic vein, (III.) The median vein (IV.) collects the blood from the superficial structures on the palmar surface of the hand and median line of the forearm, and, communicating with the anterior radial and ulnar veins at the bend of the elbow, it receives a branch of communication from the deep veins accompanying the brachial artery (A), and divides into two branches, which diverge from each other as they ascend. The median basilic vein (V.) passes inward in the groove of the biceps muscle, and joins the common ulnar to form the basilic vein; it passes in front of the brachial artery, and is separated from it by the bicipital fascia. The basilica vein (II.) is very large, and, formed by the common ulnar vein with the median basilic, it passes upward along the line of the biceps muscle on the inner side, and ascends in the course of the brachial artery (A). The cephalic vein (III.) courses along the outer border of the biceps muscle to the upper third of the arm; it then passes in the interval between the pectoralis major and deltoid muscles, and terminates in the axillary vein just below the clavicle; this vein is sometimes connected with the

external jugular or subclavian by a branch which passes from it upward in front of the clavicle

## THE DEEP VEINS OF THE UPPER EXTREMITY.

(Same plate.)

The deep veins of the upper extremities follow the course of the arteries, forming their venæ comites. These are two in number, one lying on each side of the corresponding artery, and are connected by short transverse branches a little distance apart. There are two digital veins accompanying each artery along the sides of the fingers, and there, uniting at their base, they pass along the spaces into the palm of the hand, and terminate in the two venæ comites, which accompany the superficial palmar arch. The deep ulnar veins, as they pass in front of the wrist, communicate with the interosseus and superficial veins, and at the elbow unite with the deep radial veins, to form the venæ comites of the brachial artery (A). The interosseous veins accompany the anterior and posterior interosseous arteries; the anterior interosseous veins commence in the front of the wrist, where they communicate with the deep radial and ulnar veins, and terminate in the venæ comites of the ulnar artery (G, Sec. 4). The deep palmar veins accompany the deep palmar arch, communicate with the superficial palmar veins at the inner side of the hand, and on the outer side terminate in the venæ comites of the radial artery (B, section 2). At the wrist they receive branches which unite with the deep radial vein, as they are in company with the radial artery, and terminate in the venæ comites of the brachial artery (A, section 2). The brachial veins (V, section 2) are situated one on either side of the brachial artery. At the lower margin of the axilla they unite with the basilic

to form the axillary vein. All the deep veins have many anastomoses, not only with each other, but with many of the superficial veins.

### VEINS OF THE SHOULDER AND CHEST.

The axillary vein is of large size, and is formed by the junction of the venæ comites of the brachial artery with the basilic vein. It begins at the lower part of the axillary space, increases in size as it ascends by receiving tributaries corresponding with the branches of the axillary artery, and terminates immediately beneath the clavicle, at the outer margin of the first rib, where it becomes the subclavian vein. Near its termination it receives the cephalic vein. The subclavian vein (5, Blood Formation) is the continuation of the axillary. It extends from the outer margin of the first rib to the inner end of the sterno-clavicular articulation, where it unites with the internal jugular to form the innominate veins (14, Blood Formation). It occasionally rises in the neck to a level with the third part of the subclavian artery (3, Blood Formation). The innominate veins are two large trunks (14, Right and Left), laid one on each side of the root of the neck, and formed by the union of the internal jugular and subclavian veins of the corresponding side. There is but one innominate artery (3, Blood Formation). The right innominate vein is short, about one and one-half inches in length, commences at the inner end of the clavicle, and, passing downward, joins the left vena innominata just below the first rib, near the right border of the sternum, forming the superior vena cava (13, Blood Formation). It is superficial and external to the arteria innominata. The left innominate vein is about three inches in length, and larger than the right. It passes from left to right across the

chest, inclines downward to unite with its fellow of the opposite side, thus forming the superior vena cava. The internal mammary veins are two in number to each artery, and follow the course of the artery of the same name. The superior intercostal veins return the blood from the upper intercostal spaces. The right vein is much smaller than the left, and corresponds with the superior intercostal artery. The left superior intercostal vein varies in size, being smaller when the left upper azygos vein is large, and *vice versa*. The superior vena cava (13, Blood Formation) receives the blood which is conveyed to the heart from the whole of the upper half of the body, and also the contents of the right lymphatic (37, Blood Formation) and thoracic ducts (29, Blood Formation). It is a short, valveless trunk, varying from two inches and a half to three inches in length, and is formed by the junction of the two venæ innominatæ. It enters the pericardium about one inch and a half above the heart, and terminates in the upper part of the right auricle. Just before it enters the pericardium it receives the vena azygos major (13, Blood Formation). The azygos veins connect the superior and inferior venæ cavæ, supplying the place of those vessels in the part of the chest which is occupied by the heart. The right, or larger azygos vein — azygos major — (1, rear section of Body plate) begins opposite the first or second lumbar vertebra by a branch from the right lumbar veins, and sometimes by a branch from the inferior vena cava. It enters the thorax through the aortic opening in the diaphragm, passes along the right side of the vertebral column, and terminates in the superior vena cava, just before that vessel enters the pericardium. In the thorax, it lies upon the intercostal arteries on the right side of the

aorta. The left or smaller azygos vein (azygos minor) begins in the lumbar region by a branch from one of the lumbar veins, passes into the thorax through the left crus of the diaphragm, ascends on the left side of the spine as high as the sixth or seventh dorsal vertebra, and terminates in the right azygos vein. The bronchial veins return the blood from the substance of the lungs, the right vein opening into the vena azygos major, the left into the left superior intercostal vein.

### THE SPINAL VEINS.

The spinal veins are arranged in four sets: the *dorsi-spinal* veins, or those situated on the exterior of the spinal column; the *meningo-rachidian* veins, or those situated in the interior of the spinal canal; the *venæ bases vertebrarum*, or the veins of the bodies of the vertebræ; the *medulli-spinal*, or the veins of the spinal cord.

The dorsi-spinal veins commence by small branches which receive their blood from the back of the spine and from the muscles in the vertebral grooves. They form a network which surrounds the spinous process, the laminæ, and the transverse and articular processes of all the vertebræ. They terminate by joining the vertebral veins in the neck, the intercostal veins in the thorax, and the lumbar and sacral veins in the loins and pelvis.

The meningo-rachidian veins, the principal veins contained in the spinal canal, are situated between the theca vertebralis and the vertebræ, and are two in number, the anterior longitudinal spinal vein, and the posterior longitudinal spinal vein. The anterior longitudinal spinal vein consists of two large tortuous venous canals which extend along the whole length of the vertebral column from the foramen magnum to the base of the coccyx (26, Skeleton

plate); the posterior longitudinal spinal veins are smaller than the anterior, and are situated one on either side between the inner surfaces of the laminæ and the theca vertebralis. Like the anterior veins, they communicate opposite each vertebra by transverse trunks.

The veins of the bodies of the vertebræ emerge from the foramina on their posterior surface, and join the transverse trunk connecting the anterior longitudinal spinal veins. In advanced age they become greatly developed.

The veins of the spinal cord are valveless, and consist of a tortuous venous plexus which covers the entire surface of the cord, and is situated between the pia mater and arachnoid. Near the base of the skull these veins unite and form several small trunks, which communicate with the vertebral veins, and there terminate in the interior cerebellar veins. There are no valves in the spinal veins, and, as a consequence, they get thoroughly injected with the fluid.

### THE SUPERFICIAL VEINS OF THE LOWER EXTREMITY.

(See plate, Upper and Lower Extremity.)

The veins of the lower extremity are more fully supplied with valves than those of the upper, and are divided into two sets, superficial and deep. The superficial veins are placed beneath the integument between the two layers of superficial fascia; and are subdivided into the *internal* or *long saphenous*, and the *external* or *short saphenous veins*. The internal or long saphenous vein (1, Sec. 1) is very easily seen. It commences at the inner side of the arch on the dorsum of the foot, ascends in front of the inner malleolus and along the inner side of the leg; at the knee it passes backward behind the inner condyle of the femur, or thigh bone (1, Sec. 4), then ascends along

the inside of the thigh, and terminates in the femoral vein (1, plate 2 and 3, Leg) about one inch and a half below Poupart's ligament. This vein (1, Sec. 1, Leg) communicates in the foot with the internal plantar vein, in the leg with the posterior tibial veins, at the knee with the articular veins, and in the thigh with the femoral vein. It possesses from two to six valves, more numerous in the thigh than in the leg. The external or short saphenous vein commences at the outer side of the arch on the dorsum of the foot, ascends behind the outer malleolus, and along the outer border of the tendo Achilles, passes directly upward, and terminates in the popliteal vein. Before it perforates the deep fascia, it gives off a communicating branch, which passes upward to join the internal saphenous vein. It also has a number of valves, one of which is always found at its termination in the popliteal vein.

## THE DEEP VEINS OF THE LOWER EXTREMITY.

(See plate, Upper and Lower Extremity.)

The deep veins of the lower extremity accompany the arteries and their branches, and are called the venæ comites of these vessels. They are more fully supplied with valves than the superficial veins, and are largely subdivided. The external and internal plantar veins (F, plate 5, Leg and Foot) unite to form the posterior tibial veins, which accompany the posterior tibial artery, and are joined by the peroneal veins. The anterior tibial veins are formed by a continuation upward of the venæ comites of the dorsalis pedis artery (A, plate Leg). They pass between the bones of the leg, tibia and fibula, and form, by their junction with the posterior tibial (plate 5, Lower Extremity), the popliteal vein (plate 5, Lower Extremity).

The popliteal vein is formed by the junction of the venæ comites of the anterior and posterior tibial vessels, ascends through the popliteal space, and becomes the femoral vein (plate 5, Lower Extremity). In this vein there are usually four valves, and in the lower part of its course it is placed internal to the artery.

The femoral vein possesses four or five valves, and accompanies the femoral artery through the upper two-thirds of the thigh, in its lower course lying on the outside, and higher up back of the artery. Near its termination it is joined by the profunda femoris vein, and again, about one and one-half inches below Poupart's ligament, by the internal saphenous vein.

## ABDOMINAL VEINS.

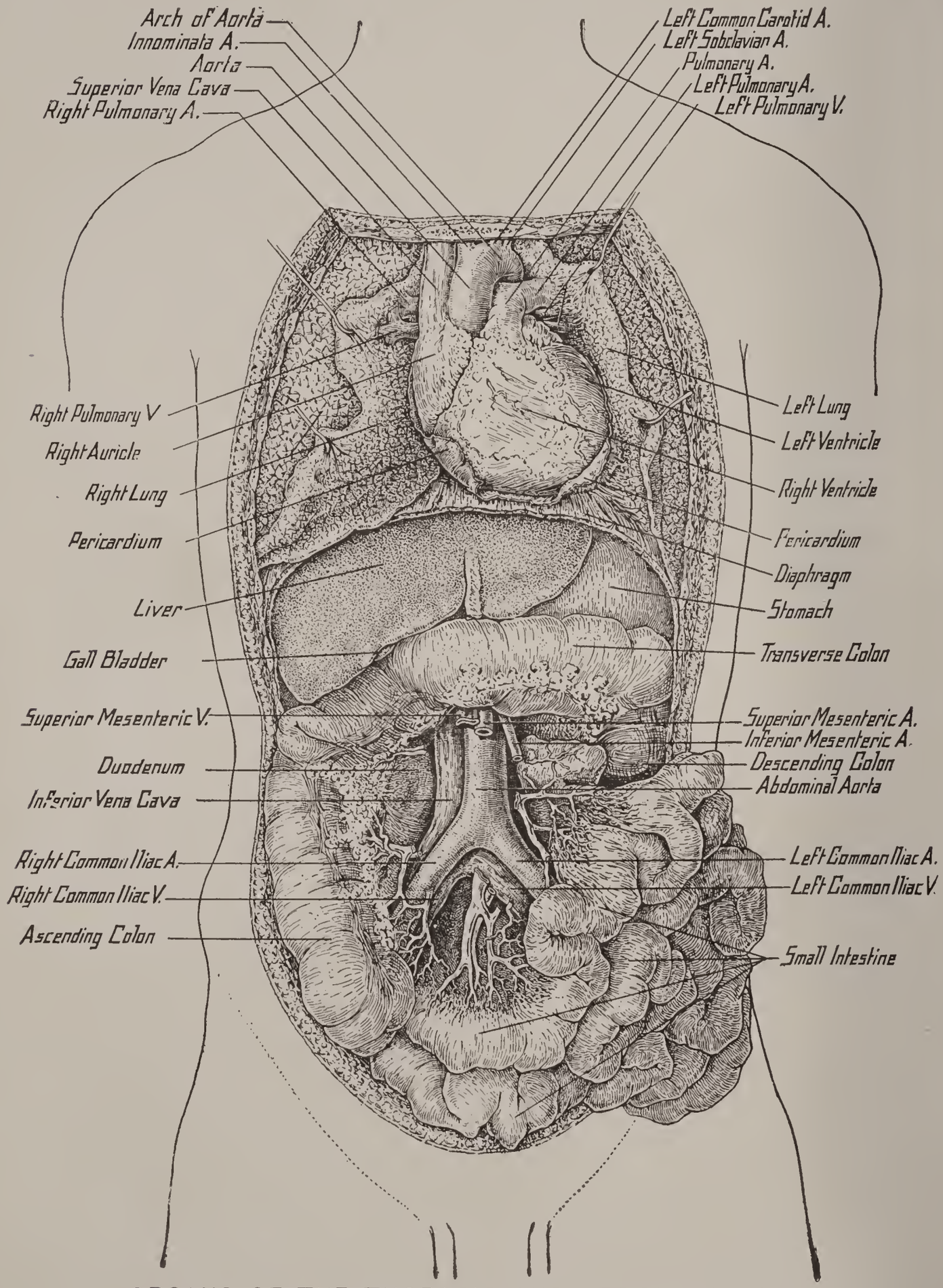
The external iliac vein (F, back plate Body) commences at the termination of the femoral vein, beneath the crural arch, passes upward and terminates opposite the sacro-iliac symphysis by uniting with the internal iliac (F, back plate Body) to form the common iliac vein (G, back plate Body). The internal iliac vein (F, back plate Body) is formed by the venæ comites of the branches of the internal iliac artery (F, back plate Body), and lies at first on the inner side and then behind the internal iliac artery. It terminates opposite the sacro-iliac articulation by uniting with the external iliac to form the common iliac vein. This vessel has no valves. The dorsal vein of the penis (plate, Male Genital Organs) is a vessel of large size, which returns the blood from the body of that organ. The common iliac veins (G, back plate Body) are formed by the union of the external and internal iliac veins in front of the sacro-vertebral articulation. Passing upward toward the right side, they terminate upon the intervertebral sub-

stance between the fourth and fifth lumbar vertebræ (12, Skeleton plate), where the veins of the two sides unite at an acute angle to form the inferior vena cava (E, back plate Body). The right common iliac vein is shorter than the left, and ascends behind and then to the outer side of its corresponding artery. The left common iliac vein (G, back plate Body) is more oblique in its course, and is situated at first on the inner side of its corresponding artery, and then behind the right common iliac artery. No valves are found in these veins.

The inferior vena cava (E, back plate Body) returns to the heart the blood from all the parts below the diaphragm. It is formed by the junction of the two common iliac veins (G, back plate Body), passes upward along the front of the spine on the right side of the aorta (A, back plate Body), then through a groove under the liver, and, perforating the tendinous center of the diaphragm, enters the pericardium, and terminates in the lower part of the right auricle of the heart. At its termination in the auricle, it is provided with a valve called the Eustachian valve.

The renal veins (W, back plate Body) are of large size, and are placed in front of the renal artery (V, back plate Body). The left is longer than the right, and, passing in front of the aorta, just below the origin of the superior mesenteric artery (Y, back plate Body), it opens a little above the right into the vena cava (E, back plate Body). The supra-renal veins terminate on the right side in the vena cava, and on the left side in the left renal or phrenic vein. The phrenic veins, two superior and two inferior, follow the course of the phrenic arteries. The hepatic veins (19, Blood Formation), three in number, commence in the substance of the liver, in the capillary terminations

A Few of the Parts from a Human Subject in twenty Dissections, showing the exact positions of the Arteries, Veins, Nerves and Muscles throughout the human body, also the organs of the Thoracic and Abdominal Cavities in their normal places.




ORGANS OF THE THORACIC AND ABDOMINAL CAVITIES.

of the portal vein (23, Blood Formation). They run singly, and have no valves.

## THE PORTAL VENOUS SYSTEM.

The portal venous system is composed of four large veins which collect the venous blood from the viscera of digestion. The trunk formed by their union — the vena porta (23, Blood Formation) — enters the liver, ramifies throughout its substance and its branches, and emerges from that organ as the hepatic veins (19, Blood Formation), which terminate in the inferior vena cava (18, Blood Formation).

The branches of these veins are in all cases single, and destitute of valves. The veins forming the portal system are *the inferior mesenteric* (22, Blood Formation), *the superior mesenteric* (22, Blood Formation), *the splenic* (21, Blood Formation), and *the gastric* (20, Blood Formation). The inferior mesenteric vein returns the blood from the rectum, sigmoid flexure (14, Intestine plate), and the descending colon (14, Intestine plate). The superior mesenteric vein returns the blood from the small intestines, the cæcum, and ascending and transverse portions of the colon, corresponding with the distribution of the branches of the superior mesenteric artery.

The splenic vein (21, Blood Formation) commences by five or six large branches which return the blood from the substance of the spleen; these unite and form a single vessel, which passes from left to right behind the upper border of the pancreas (19, back plate Body) below the artery, and terminates at its greater end by uniting at a right angle with the superior mesenteric vein to form the vena porta. The splenic vein is large, and not tortuous like the artery. The gastric veins (20, Blood Formation)

are two in number: one, a small vein, corresponds to the pyloric branch of the hepatic artery (8, Blood Formation); the other, much larger, corresponds to the gastric artery (7, Blood Formation). The former, pyloric, runs along the lesser curvature of the stomach toward the pyloric, receives branches from the pylorus (4, Stomach) and duodenum (5, Stomach), and ends in the vena porta. The latter, coronary, begins near the pylorus, runs along the lesser curvature of the stomach, and then curves downward between the folds of the lesser omentum to end in the vena portae (23, Blood Formation). The portal vein is formed by the junction of the superior mesenteric and splenic veins, their union taking place in front of the vena cava (18, Blood Formation), and behind the upper border of the great end of the pancreas. The portal vein is about four inches in length, and lies behind the hepatic duct and artery — the former to the right, the latter to the left. Within the liver the portal vein receives the blood from the branches of the hepatic artery.

## THE CARDIAC VEINS.

The cardiac veins are the veins which return the blood from the substance of the heart, and are, namely, the *great cardiac* vein, the *middle cardiac* vein, the *posterior cardiac* vein, the *anterior cardiac* veins, the right or *small cardiac* vein, and the *vena Thebesii*. The great cardiac vein (Heart) — coronary — is a vessel of considerable size which commences at the apex of the heart, and ascends along the anterior interventricular groove to the base of the ventricles (Heart). The middle cardiac vein commences by small tributaries at the apex of the heart, ascends along the posterior interventricular groove to the base of the heart, and

terminates in the coronary sinus. Its orifice is guarded by a valve.

The posterior cardiac veins are four small vessels which collect the blood from the posterior surface of the left ventricle (Heart), and open into the lower border of the coronary sinus. The anterior cardiac veins (Heart) are three small vessels which collect the blood from the anterior surface of the right ventricle (Heart), and open separately in the lower part of the right auricle (Heart). The right or small coronary vein (Heart) runs along the groove between the right auricle (Heart) and ventricle (Heart) to open into the right extremity of the coronary sinus. It receives blood from the back part of the right auricle (Heart) and ventricle (Heart). The venæ Thebesii are many minute veins which return the blood directly from the muscular substance without entering the venous current. They open by minute orifices on the inner surface of the right auricle (Heart). The coronary sinus is that portion of the great cardiac vein which is situated in the posterior part of the left auriculo-ventricular groove. It is about one inch in length, presents considerable dilatation, and receives the veins enumerated above. The coronary sinus terminates in the right auricle (Heart), its orifice being guarded by the coronary valve. All these vessels are provided with valves. The description given here of the veins will serve our purpose in the art of embalming, and it is unnecessary for us to go into further details.

## THE BRAIN AND ITS MEMBRANES.

(See Head section in Aid.)

The brain is that portion of the cerebro-spinal axis contained in the cranial cavity. It is divided into four princi-

pal parts, named the medulla oblongata (30), the pons Varolii, the cerebellum (28), and the cerebrum (27). The medulla oblongata extends from the lower border of the pons to the upper part of the spinal cord, with which it is continuous. The pons is that part of the brain which rests upon the upper portion of the basilar process (58) and body of the sphenoid bone. The cerebellum, the little or after brain, is situated in the inferior pair of occipital fossæ. It consists both of gray and white matter, and its outer surface has a foliated appearance, due to its subdivision by numerous fissures. The cerebrum forms the largest portion of the brain, and lies above both the pons and cerebellum. It is composed both of gray and white matter, is ovoid in shape, is subdivided into hemispheres, and its surface presents a series of convolutions, separated from each other by fissures. Of these, the five principal fissures are the great longitudinal fissure, separating the hemispheres, and the fissure of Sylvius, the fissure of Rolando, and the parieto-occipital fissure, which separates the lobes of the brain. The membranes of the brain are the dura mater, the arachnoid, and the pia mater. The dura mater is a thick, inelastic fibrous membrane, which lines the interior of the skull, its numerous arteries being distributed to the bone. The arachnoid — so named from its resemblance to a spider's web — is a delicate, transparent membrane, which loosely envelopes the brain, its structure consisting of bundles of white, fibrous and elastic tissue intimately blended. It lies between the dura and pia mater. The pia mater is a vascular membrane closely investing the whole outer surface of the brain and dipping into the fissures.

## THE PHARYNX.

The pharynx (50, Head plate) is that part of the alimentary canal which is situated behind the nose, mouth and larynx (56, Head Plate).

It is conical in form, its base upward and apex downward, is about four and a half inches in length, and broader in its transverse than in its antero-posterior diameter. Below, it is continuous with the œsophagus (57). The pharynx is composed of three coats, mucous, fibrous and muscular; the fibrous coat, situated between the mucous and muscular layers, is called the pharyngeal aponeurosis.

## THE ŒSOPHAGUS.

(See 57, Head plate in Aid.)

The œsophagus, or gullet (57), is a muscular canal about nine inches in length, extending from the pharynx (50) to the stomach.

It passes through the diaphragm, and, entering the abdomen, terminates at the cardiac orifice of the stomach (3, plate of stomach), opposite the ninth dorsal vertebra. The œsophagus has three coats, an external or muscular, a middle or areolar, and an internal or mucous coat.

## THE THORAX.

The thorax is a conical framework, made up partly of bones, and partly of soft tissues connecting them. It is narrow above, broad below, flattened before and behind; is bounded in front by the sternum, the six upper costal cartilages, the ribs and intercostal muscles; at the sides by the ribs and the intercostal muscles, and behind by the dorsal vertebra column. The superior opening of the thorax is bounded on each side by the first rib, in front by the upper part of the sternum (6), and behind by the

first dorsal vertebra. It is broader from side to side than from before backward, its direction being forward and upward. The lower opening or base is bounded in front by the cusiform cartilage, behind by the last dorsal vertebra, and on each side by the last rib, the diaphragm filling in the intervening space. Passing through the upper opening of the thorax are the sterno-hyoid and sterno-thyroid muscles, the trachea (24, Head), the œsophagus (57), the thoracic duct (29, Blood Formation), and the longus colli muscles of each side; at the sides the arteria innominata (2, Blood Formation), the left common carotid (1, Blood Formation), left subclavian arteries (3, Blood Formation), and many other smaller parts. The apex of each lung, covered by the pleura, also projects through this aperture a little above the margin of the first rib. The viscera contained in the thorax are the heart, inclosed in the pericardium; and the lungs, invested by the pleura.

## THE HEART.

(Body Section of Aid, also Blood Formation.)

The heart is a hollow muscular organ of a conical form, placed between the lungs, and inclosed in the cavity of the pericardium. The pericardium is a conical membranous sac, which, with the inclosed heart and the commencement of the great vessels, lies behind the sternum (6, Body plate), its apex upward, its base attached to the central tendon. Externally, the pericardium is a strong fibrous membrane. The position of the heart in the chest is oblique, its base directed upward and to the right, its apex directed downward, forward, and a little to the left. It is placed behind the lower two-thirds of the sternum, and projects farther into the left cavity of the chest than into the right. Its anterior surface is round and convex, its posterior flattened

and resting upon the diaphragm; the right border is thin and sharp, the left border short, but thick and round. In the adult, the heart measures five inches in length, three and one-half inches in breadth at broadest part, and two and one-half inches in thickness; its average weight in the male is ten ounces, in the female about eight ounces. The heart is subdivided, by a longitudinal muscular septum, into lateral halves, which are named, from their position, the right and the left. A transverse constriction divides each half of the organ into two cavities, the upper cavities on each side being called the auricles, and the lower cavities the ventricles. The right auricle (25, Blood Formation) receives the blood from all parts of the body by the ascending (18, Blood Formation) and descending (13, Blood Formation) venæ cavæ, and forces it through the auriculo-ventricular orifice (8, Body Section) into the ventricles for its entrance into the pulmonary artery (5, Blood Formation), so that in its passage through the lungs the blood becomes oxidized or aërated before its entrance into the left side of the heart for its final distribution throughout the general system. The right auricle (25, Blood Formation) is a trifle larger than the left, its walls being thinner, and its cavity capable of holding about two ounces of blood. The auriculo-ventricular orifice is a large oval aperture, about one inch in diameter, between the auricle and ventricle. The heart contains valves which open when the auricle contracts, and close when the auricle dilates, thus preventing regurgitation.

## THE LUNGS.

(See Body plate in Aid.)

The lungs are two large, spongy masses situated in the cavity of the chest, and extending from the first rib to the

diaphragm. They receive the blood from the pulmonary artery and oxidize or aërate it, sending it purified to the left side of the heart to be distributed to its general circulation. In shape the lungs are conical, and present an apex, a base, two borders and two surfaces. The apex extends into the root of the neck about one inch above the level of the first rib. The base is broad, and rests upon the convex surface of the diaphragm; the posterior border is round and broad, and is received in the deep concavity on either side the spinal column; the interior border is thin and sharp and laps over the front of the pericardium. The two lungs are in contact in the middle line, the pleura only being interposed. Each lung is divided into two lobes. The pleura, which invests each lung on its external surface, is an exceedingly delicate sac-shaped membrane, and incloses the lung as far as its root. The interspace or cavity between the layers is called the cavity of the pleura.

## THE STOMACH.

(See plate of Stomach in body of Aid.)

The stomach is the principal organ of digestion. It is placed immediately behind the anterior wall of the abdomen, above the transverse colon (12), below the liver (1-2) and the diaphragm. Its size varies in different individuals, but when moderately full its transverse diameter is usually about twelve inches, its vertical diameter four inches, its weight five ounces. It has two orifices, two extremities, two borders, and two surfaces. Its left extremity, called the greater or splenic end, is the largest part of the stomach, and extends two or three inches to the left of the point of entrance of the œsophagus (1); the pyloric end (4) is much smaller. The œsophageal or cardiac orifice

(2) communicates with the œsophagus, is the highest part of the stomach, and is somewhat funnel shaped; the pyloric orifice(4) communicates with the duodenum (5), the aperture being guarded by a valve — the pylorus (4). The structure of the stomach consists of four coats. The arteries supplying the stomach are the gastric (7, Blood Formation), the pyloric and right gastro-epiploic branches of the hepatic (8, Blood Formation), the left gastro-epiploic and vasa brevia from the splenic (9, Blood Formation).

## THE INTESTINES.

(See Intestine plate in body of Aid.)

The small intestine is that part of the alimentary canal in which the chyme is mixed with the bile, the pancreatic juice and the secretions of the various glands imbedded in the mucous membrane of the intestine, and also where the separation of the chyle, the nutritive principle of the food, is effected. It is a convoluted tube about twenty feet in length, gradually diminishing in size from its commencement to its termination, and contained in the central and lower parts of the abdominal cavity, surrounded above and at its sides by the large intestine. The small intestine is divided into three portions, the *duodenum* (5, Body), the *jejunum* (7), and the *ileum* (7). The duodenum is about ten inches in length, and is the shortest, the widest and the most fixed part of the small intestine. It has no mesentery, and is only partly covered by the peritoneum (A 2); its curve is similar to a horse-shoe in form, the convexity directed to the right, the concavity to the left, and, embracing the head of the pancreas (19, Body), it terminates in the jejunum on the left side of the second lumbar vertebra. The jejunum, so called because it is usually found empty after death, includes the upper two-

fifths of the small intestine. It commences at the duodenum and terminates in the ileum, and, though wider and possessing coats thicker and of a deeper color than those of the ileum, it is very difficult to distinguish the line of demarkation of the two vessels. The ileum (7), so called from its numerous coils or convolutions, includes the remaining three-fifths of the small intestine, and terminates in the right iliac fossa by opening into the inner side of the commencement of the large intestine. The ileum is narrower, its coats thinner, and less vascular than those of the jejunum.

The large intestine commences at the ileum, and terminates at the anus. It is about five feet in length, being one-fifth of the whole extent of the intestinal canal, is largest at its commencement, and gradually diminishes as far as the rectum, where there is a dilatation of considerable size just above the anus. It differs from the small intestine in its greater size, its more fixed position, and its sacculated form. Commencing in the right side (the cæcum) (9), it ascends to the under part of the liver, travels across the abdomen through the epigastric and umbilical regions to the left hypochondriac region, descends to the left iliac fossa, where it forms the sigmoid flexure, then descends through the pelvis to the anus, in its course having described an arch surrounding the convolution of the small intestine. The large intestine is divided into three sections or divisions, called the cæcum (9), the colon (14), and the rectum. The cæcum, that part or sac in which the large intestine commences, is two and one quarter inches in length, in breadth three inches. The colon (14) is divided into four parts, the ascending, the descending, the transverse and the sigmoid flexure (last plate Female Genital Organs). The ascending

colon (10) is smaller than the cæcum; the transverse colon (12) is the longest part of the large intestine, and passes transversely across the abdomen from right to left, in its course describing an arch; the descending colon passes almost vertically downward to the left iliac fossa, where it terminates; the sigmoid flexure, the narrowest part of the colon, is situated in the left iliac fossa, commencing where the descending colon terminates, and ending in the rectum; the rectum is the terminal part of the large intestine, and extends from the sigmoid flexure to the anus, and is from six to eight inches in length. The large intestine has four coats, the serous, the muscular, the cellular, and the mucous. Both the large and small intestine are supplied with blood by the superior and inferior mesenteric arteries (11, Blood Formation), as well as from many of the abdominal branches, which are all branches from the aorta (4, Blood Formation).

## THE ABDOMEN.

(See Body Section of Aid.)

The abdomen is the largest cavity in the body. It is oval in form, and is bounded in front and at the sides by the lower ribs and the abdominal muscle, behind by the vertebral colnmn, above by the diaphragm, and below by the brim of the pelvis. The abdomen contains the greater part of the alimentary canal, and some of the accessory organs to digestion; viz., the liver, pancreas, and spleen, and the kidneys and supra-renal capsules. For convenience of description, the abdomen is divided into nine separate regions; the right upper region is called the right hypochondriac, the left upper region the left hypochondriac, the upper center region the epigastric, the right center region the right lumbar, the central region the

umbilical, the left central region the left lumbar, the right lower region the right inguinal, the central lower region the hypogastric, and the left lower region the left inguinal.

The right hypochondriac region contains the right lobe of the liver, the gall-bladder, part of the colon, and part of the right kidney The right lumber region contains the ascending colon, part of the right kidney, and a small portion of the small intestines. The right inguinal region contains the cæcum (9, Stomach plate), the ureter (24, Back plate), and spermatic vessels. The epigastric region contains the middle and pyloric end of the stomach, the left lobe of the liver, the pancreas (19), the duodenum, parts of the kidneys, the supra-renal capsules, the aorta, and branches of the vena cava and thoracic duct. The umbilical region contains the transverse colon, part of the great omentum and mesentery, part of the duodenum (5, Stomach Plate), some portions of the jejunum (7), and ileum (7), also part of both kidneys. The hypogastric region contains the convolutions of the small intestines, the bladder if distended, and the uterus during pregnancy. The left hypochondriac region contains the splenic end of the stomach, the spleen and extremity of the pancreas, the splenic flexure of the colon and part of the left kidney. The left lumber region contains the descending colon, part of the omentum, part of the left kidney and some parts of the small intestines. The left inguinal region contains the sigmoid flexure of the colon, the ureter, and spermatic vessels.

### THE LIVER.

(See Body Section of Aid.)

The liver is a glandular organ of very large size, which secretes the bile, and effects changes in the blood in its

passage through the gland. It is situated on the right side, in what is known as the right hypochondriac and epigastric regions, and is the largest gland in the body, weighing from three and one-half to four pounds; its measurements transversely being from ten to twelve inches, six to seven inches in thickness, and about three inches at the back of the right lobe (1), that being the thickest part. Its upper surface is convex, smooth and covered by peritoneum; its under surface concave, directed downward and backward. Five fissures are seen upon the under surface of the liver, named the longitudinal fissure, the fissure of the ductus venoses, the transverse fissure, the fissure for the gall-bladder (3), and the fissure for the inferior vena cava. The longitudinal fissure is a deep groove, which separates the right lobe of the liver from the left; the fissure of the ductus venoses is the back part of the longitudinal fissure, and is shorter and more shallow than the anterior portion; the transverse, or portal fissure, is short but deep, and years ago was supposed to be a gateway of the liver, therefore the large vein which enters at this point was called the portal vein (4); the fissure for the gall-bladder is shallow and oblong, and, placed on the under surface of the right lobe, it extends from the anterior free margin of the liver; the fissure of the interior vena cava (5) is short and deep, almost a complete canal, and extends upward from behind the right extremity of the transverse fissure to the posterior border of the liver, where it joins the fissure for the ductus venoses. The right lobe of the liver is larger than the left, in proportion about six to one, occupies the right side almost exclusively, and is separated from the left lobe on its upper surface by the longitudinal ligament. The left lobe is more flattened than the right, its upper

surface convex, its under surface concave, is situated in the epigastric region, and rests upon the front of the stomach. The vessels connected with the liver, five in number, are the hepatic artery (between 7 and 4), the portal vein (4), the hepatic vein (smaller 5), the hepatic duct (7), and the lymphatic. The substance of the liver is composed of lobules held together by an extremely fine areolar tissue, the lobules forming the chief of the hepatic substance.

### THE GALL-BLADDER.

(3. See Plate of Liver in Aid.)

The gall-bladder, the reservoir for the bile, is pear-shaped, and lies on the under surface of the right lobe of the liver. It is about four inches in length, one inch in breadth, and holds about one ounce.

### THE PANCREAS.

(See Last Plate of Body in Aid.)

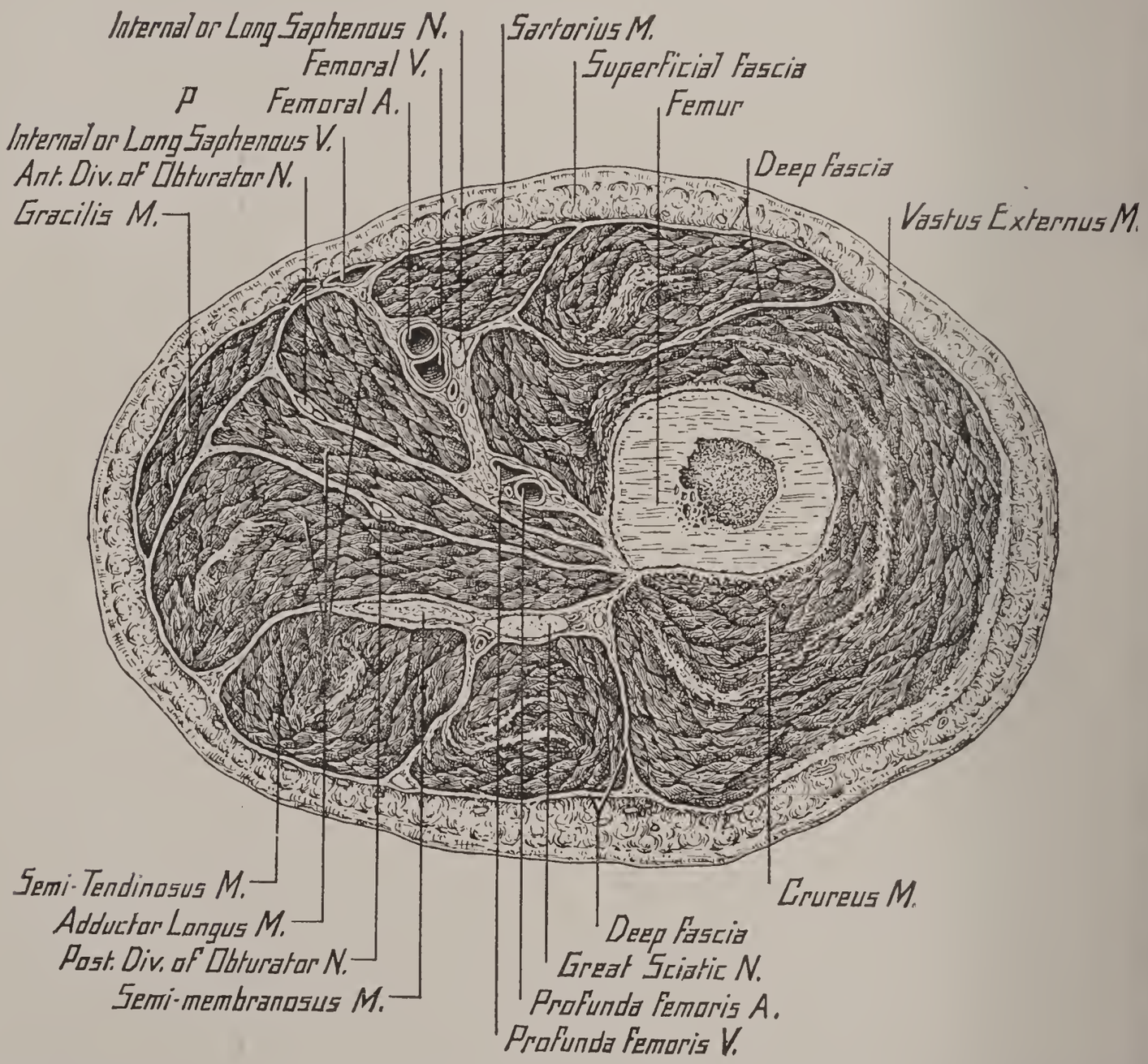
The pancreas (19), which is a compound gland, analogous in its structure to the salivary glands, is situated across the posterior wall of the abdomen. In shape it is transversely oblong and flat, in length about seven inches, one inch and a half in breadth, and about three-quarters of an inch in thickness. Its weight is from three to four ounces. The arteries of the pancreas are derived from the splenic (U) and pancreatico-duodenal branches of the hepatic (8, Blood Formation) and the superior mesenteric; its veins open into the splenic (21, Blood Formation) and superior mesenteric veins (22, Blood Formation).

### THE SPLEEN.

(See Last Plate of Body in Aid.)

The spleen (18) is an oblong, flattened form, soft, of very brittle consistence, of a dark-blue color, and situated in the left hypochondriac region. Its external surface is

A Few of the Parts from a Human Subject in twenty Dissections, showing the exact positions of the Arteries, Veins, Nerves and Muscles throughout the human body, also the organs of the Thoracic and Abdominal Cavities in their normal places.




TRANSVERSE SECTION OF THE LEG IN REGION WHERE THE FEMORAL ARTERY IS USUALLY RAISED.

convex, smooth, and in relation with the under surface of the diaphragm, which separates it from the ninth, tenth, and eleventh ribs on the left side. The internal surface is slightly concave, and, divided by a fissure, is in relation in front with the great end of the stomach, below with the tail of the pancreas. The upper end is thick and round, the lower end is pointed. The spleen is held in position by two folds of peritoneum, one connecting it with the stomach, the other, the suspensory ligament, with the under surface of the diaphragm. Though varying in size, the spleen is usually found to be about five inches in length, from three to four inches in breadth, about one and one-half inches in thickness, its weight being about seven ounces.

### THE KIDNEYS.

(Back Plate of Body in Aid.)

The kidneys (20) are situated in the back part of the abdomen, in the loins, one on each side of the vertebral column, resting upon the lower part of the diaphragm, and are surrounded by a large quantity of fat and loose tissue. Sometimes the kidney, becoming loosened from this vast quantity of fat, is only held by the blood-vessels and ureter (24), and it is then called a "floater." The right kidney is usually lower than the left, and is covered in front by the right lobe of the liver, the descending portion of the duodenum, and the ascending colon; the left, a trifle longer than the right, has in front the fundus of the stomach, the tail of the pancreas, and the descending colon. In shape the kidney is convex outside or posteriorly, and concave on its internal border; it also presents a pelvis (22) for examination. Each kidney is about four inches in length, about two and a half inches in

breadth, and a trifle more than one inch in thickness; its weight varies in the adult male from five to six ounces, in the adult female it is about five ounces. The ureters (24), two in number, are tubes which conduct the urine from the kidneys into the bladder. They are from sixteen to eighteen inches in length, and in diameter about the size of an ordinary goose-quill, and extend from the pelvis (22) of the kidney to the bladder. They possess three coats, muscular, mucous and fibrous.

### THE BLADDER.

(See Body Section of Aid.)

The bladder is a reservoir which contains the urine. It is a muscular, membranous sac or pouch, in the male situated in the pelvis (22), behind the os pubes and in front of the rectum; in the female, between the rectum, the uterus and the vagina. It is capable of very great distension, but in its usual condition measures about five inches in length, three inches across, and ordinarily it contains about one pint. The structure of the bladder is made up of four coats, a serous, a muscular, a sub-mucous and a mucous coat. The arteries supplying the bladder are the superior, middle, and inferior vesical in the male, the female having additional branches from the uterus and vagina. The male urethra extends from the neck of the bladder to the meatus urinarius, its length varying from eight to nine inches, its caliber about three-eighths of an inch. It is composed of one continuous mucous membrane, and is supplied with blood from the branches of the inferior vesical, the internal iliac, and the dorsal artery.

### THE DIAPHRAGM.

The diaphragm is a thin, muscular, fibrous septum, separating the thorax from the abdomen, forming the floor

of the thoracic cavity and the roof of the abdominal cavity. It is nearly fan-shaped, has three large openings and several smaller openings, the former for the passage of the aorta, the œsophagus and the vena cava. It is arched, being convex toward the chest and concave to the abdomen, and is supplied with blood by the phrenic artery. The diaphragm is constantly called into action, as it is the principal muscle of respiration.

## CONDUCTING FUNERALS.

About one hour before the time set for the funeral, repair to the house with your assistants, and explain to each the duties which you expect him to perform; viz., attending the door, directing the relatives to one part of the house and friends to another, watching that there be no confusion in opening and closing camp-chairs, placing them in position in the rooms set part for that purpose, never allowing any to remain open in the hallways, receiving flowers at the door, and placing them according to directions. See that services are begun promptly—delay at such times is a cruelty. One assistant should be stationed outside, to attend to the order of the carriages. There should be no loud talking in front of the house. When everything is in readiness, there should be a man at the door to direct the relatives and friends to the carriages assigned them; another at the line of carriages, to assist the family and friends to their seats. When all are filled a motion of the hand should be given to the one in charge. When the cortege moves away, the man left at the house should set the home in order before the return of the family, removing all evidence of the funeral, carrying his paraphernalia to his office, and laying it aside carefully and well cleaned for future use. One assistant should return from the cemetery, and see to it that the family are assisted out of their coaches. Courtesy, gentleness, unobtrusiveness, thoughtfulness, sympathy—all are requisite to a proper discharge of Life's saddest ceremony.

# THE SKELETON.

*Letters and figures inclosed in parentheses, in this Handbook, refer to parts or organs similarly lettered or numbered on sections or plates.*

## INDEX TO PLATE.

(1) Frontal.
(2) Parietal.
(3) Temporal.
(4) Mastoid part of Temporal.
(5) Nasal.
(6) Malar.
(7) Superior Maxillary.
(8) Teeth.
(9) Inferior Maxillary.
(10) Cervical Vertebræ.
(11) Dorsal Vertebræ.
(12) Lumbar Vertebræ.
(13) Clavicle.
(14) Scapula.
(15) Sternum.
- (A) Manubrium.
- (B) Gladiolus.
- (C) Ensiform Appendix.

(16) True Ribs.
(17) False Ribs.
(18) Floating Ribs.
(19) Humerus.
(20) Radius.
(21) Ulna.
(22) Carpus.
- (A) Scaphoid.
- (B) Semilunar.
- (C) Cuneiform.
- (D) Pisiform.
- (E) Trapezium.
- (F) Trapezoid.
- (G) Os Magnum.
- (H) Unciform.

(23) Metacarpus.
(24) Phalanges.
(25) Sacrum.
(26) Coccyx.
(27) Ilium.
(28) Ischium.
(29) Pubes.
(30) Head of Femur.
(31) Neck of Femur.
(32) Shaft of Femur.
(33) Patella.
(34) Tibia.
(35) Fibula.
(36) Tarsus.
- (A) Os Calcis.
- (B) Astragalus.
- (C) Scaphoid.
- (D) Head of Astragalus.
- (E) Internal Cuneiform.
- (F) Middle Cuneiform.
- (G) External Cuneiform.
- (H) Cuboid.

(37) Metatarsus.
(38) Phalanges.

## THE SKELETON.

The skeleton consists of two hundred bones, excluding those of the ear and the smaller sesamoid bones. The sacrum and coccyx, together, have the elements of nine vertebræ, but are counted as two bones. The bones give outline to the body, and support to the soft parts, form cavities for the protection of the important organs, and serve as levers and points of attachment for muscles in locomotion, and motion of individual parts.

As to their form, bones are classed as long, short, flat, and irregular.

Long bones have three sources of arterial supply: the periosteal vessels for the compact tissue of the shaft; the nutrient or medullary artery for the marrow and deeper parts of the shaft; the articular arteries for the cancellous tissue and red marrow of the extremities. These sets of vessels communicate freely with each other.

In structure, bone tissue is either dense or porous. The former is *compact tissue*, and is found in the shaft of the long bones and the surfaces of all bones; the latter is *cancellous tissue*, and forms the expanded ends of the long bones, and the central part of other bones. Compact tissue is disposed in concentric layers (*lamellæ*). Cancellous tissue is made by these layers separating, diverging and interlacing, the fibers being disposed in the forms of arches, which give elasticity and strength. These arches are always arranged with reference to points of pressure and traction.

Except where covered with cartilage, bones are surrounded by a dense fibrous membrane, the *periosteum*, which serves as a nidus for the subdivision and distribution of arteries to the bone beneath. It sends a sheath with

each vessel. By its under layer, which is gelatinous and contains the osteoblasts, it contributes to the growth, nutrition, and repair of bones.

Histologically, bone consists of bone spaces with their contents, and the bone tissue proper. The spaces are the *medullary cavities*, the *Haversian canals*, the *lacunæ*, and the *canaliculi*. The medullary cavities are the canals of long bones which contain yellow marrow (ninety-eight per cent. fat), and the medullary cavities of the cancellous tissue, which contain red marrow, which substance contributes to the formation of the red blood corpuscles. The medullary membrane (*endosteum*) lines these canals and spaces.

The Haversian canals average 1-500th of an inch in diameter. The larger ones contain marrow, and all convey one or more blood-vessels. The lacunæ are characteristic of true bone, as distinguished from calcareous deposits. They are insect-like cavities between the lamellæ, arranged in circles around the Haversian canals, oval-shaped, and in size 1-2000th by 1-6000th of an inch. Each one contains a soft, nucleated substance called a "bone corpuscle." The canaliculi are the channels by which the lacunæ communicate with each other and with the Haversian canals. Diameter 1-14000th of an inch and less. They contain, each, a minute process of the "bone corpuscle" of the lacunæ. This process imbibes nutrient fluid from the blood in the Haversian canals, and passes it on from one lacuna or "bone corpuscle" to another —thus supplying the bone tissue with nutrient material.

Bone tissue proper, occupies all the space between the lacunæ and canaliculi. It is one-third organic and two-thirds earthy matter. The organic matter makes the

outline and forms a bed in which the earthy matter is laid down as minute osseous granules.

The embryonic skeleton consists, at first, entirely of this animal matrix, for the most part in the form of hyaline cartilage.

Ossification begins by a deposit of bone granules in the matrix, at certain points. Each point is a "center of ossification." These centers are definite in number and in their order of succession for each bone, but vary in different bones.

The skeleton begins to ossify in the clavicle, by a center which appears the middle of the second month of fœtal life.

The primary center in a long bone is for the shaft (diaphysis). After the shaft is well advanced in ossification, secondary centers (epiphyses) appear in the articular ends of the bone. Still later, other centers appear for the processes, tuberosities, etc.

The first epiphysis to appear, and the only one present at birth, is that of the lower end of the femur. This fact is available in determining certain medico-legal questions about premature birth. Soon the diaphysis is separated from its epiphyses, only by a thin disc of cartilage (epiphyseal cartilage). Eventually, they unite and become continuous by ossification of the disc, when the individual has attained full stature. This process is completed in all long bones by the twenty-fifth year.

Of the epiphyses, that one which appears first unites last. The nutrient artery runs toward that epiphysis which unites first. The nutrient arteries run *toward* the elbow in the upper extremity, but *from* the knee in the lower limb.

Bones derive their growth in length from the epiphyseal

cartilages, but not in equal degree from the upper and lower. That epiphysis which appears first — being the one from which the nutrient artery runs — contributes most to the growth in length. Hence, in the upper extremity, the growth in length is derived mostly from the epiphyses at the shoulder and wrist, while in the lower limb those at the knee contribute most.

Growth in length is arrested if an epiphyseal cartilage is destroyed by suppuration, or prematurely ossified by inflammation. The amount of the permanent shortening of the limb resulting, will depend on which cartilage is involved, and whether its destruction has been complete or partial; and if partial, whether on the epiphyseal or diaphyseal faces of the cartilage; for that surface of the cartilage toward the diaphysis contributes about fifteen times more to the growth in length than does the epiphyseal face.

The epiphyseal cartilage, to a certain extent, serves as a barrier to the extension of inflammation and suppuration from one part to the other.

The expanded part of the shaft, between the end of the medullary canal and the epiphyseal cartilage, is called the juxta-epiphyseal portion (Ollier), and from a pathological and surgical standpoint is the most important part of the bone. It is the seat of the greatest physiological activity and prolification, and is the zone of election for all pathological processes. Also on account of its close relation to a joint, and exposed position, it is most liable to overstrain, local fatigue, and other slight traumatisms. Whence the explanation of the fact that the juxta-epiphyseal portion of long bones, and to some extent the corresponding part of other bones, is much the most frequent point of departure for inflammations and development of

neoplasms during the period of growth. Also at this period, that end of the bone which contributes most to its growth in length, is the seat of election for neoplasm and inflammatory lesions. Hence, the more frequent appearance of benign and malignant growths in the epiphyses at the shoulder, wrist and knee, than in those at the elbow, hip and ankle. So with all the inflammatory processes, tubercular, or other kind. Though, on account of certain joints being more exposed to traumatisms, the rule is not as invariable for inflammatory processes as for neoplasms.

## BLOOD FORMATION AND CIRCULATION.

(*Semi-diagrammatic.*)

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### INDEX TO PLATE.

ARTERIES.

(1) Carotid Arteries, which, with the vertebral, supply the head.
(2) Innominate Artery.
(3) Subclavian.
(4) (4) (4) Arch of the Aorta — ascending, transverse and descending portion.
(5) (5) Pulmonary Arteries, right and left, containing venous blood.
(6) Thoracic Aorta.
(7) (8) (9) Gastric, Hepatic and Splenic — branches of the Cœliac Axis, which is a branch of
(10) Abdominal Aorta.
(11) Superior Mesenteric — to small intestines and part of large.
(12) Renal.

VEINS.

(13) Vena Cava Superior.
(14) (14) Innominate — right and left.
(15) Subclavian.
(16) Jugular.
(17) Pulmonary — containing arterial blood.
(18) Vena Cava Inferior.
(19) Hepatic.
(20) Gastric.
(21) Splenic.
(22) Mesenteric.
(23) Vena Portæ.
(24) Renal (emulgent).
(25) Right Auricle.
(26) Left Auricle.
(27) Right Ventricle.
(28) Left Ventricle.
(29) Thoracic Duct.

VISCERA AND LYMPHATICS.

(30) Stomach.
(31) Spleen.
(32) Liver.
(33) Kidney.
(34) Duodenum.
(35) Ascending Colon.
(36) Descending Colon.
(37) Lymphatics of the Intestines — the vessels being called Lacteals; the glands, the Mesenteric Glands.

## THE CIRCULATION.

The *greater* or *Systemic Circulation* includes the course of the blood from the left auricle (26), through the left ventricle (28), arch of the aorta (4), the arteries to the upper extremities (3), those to the head (1), thoracic aorta (6) and its branches, abdominal aorta (10) with its branches, and its continuation and subdivisions for the lower extremities; together with the capillaries and veins corresponding to the areas of distribution of the arteries — the veins from the head and upper extremities joining to form the superior vena cava (13), which opens into the right auricle — those from the lower extremities and the pelvic and abdominal viscera join to form the inferior vena cava (18), which also opens into the right auricle.

The blood from the intestines and digestive organs passes through a second set of capillaries, in the liver, before joining the general current in the vena cava.

The *Portal Circulation* — a part of the Systemic — includes the course of the venous blood from all the organs of digestion, through the superior and inferior mesenteric veins and the splenic and gastric veins, which four trunks join to form the *portal* vein (23). This vein is about four inches long, and extends from behind the head of the pancreas to the transverse fissure of the liver, where it subdivides, and the blood, after passing through a second set of capillaries in the liver, leaves it through the *hepatic* veins, and empties into the vena cava inferior. The portal system of veins has no valves.

The *lesser* or *Pulmonic Circulation* includes the course of the blood from the right auricle (25) through the right ventricle (27), through the pulmonary arteries (5, 5), to the lungs, and its return through the pulmonary veins (17),

with a fresh supply of oxygen, to be again distributed throughout the system.

The Lymphatic System is an appendix of the Vascular System. Lymphatic vessels begin in the tissues as "lymph spaces" in connective tissue, as "perivascular spaces," and as blind tubules within the villi of mucous membrane. These spaces, or canals, unite to form tubes which unite again and converge to form the *thoracic duct* and the *right lymphatic duct*. In their course they pass through (rather empty into and begin anew) numerous lymphatic glands, which are a collection of lymph follicles, and are of the size of a pin head and larger. In structure these vessels resemble veins and have many valves. The functions of the lymphatic system are, to serve as nutrient channels in those tissues devoid of blood-vessels; as a drainage apparatus to collect and return to the blood fluids which have oozed through the capillaries to irrigate the tissues; and as absorbents and carriers of both waste products and food products. The lymphatics from the intestines are the *lacteals*, and during digestion, their contents are called *chyme*. The lymph current is from the periphery to the center only.

The *blood* is the medium of exchange between the outer world and the tissues of the body. It conveys tissue building materials from without — food products from the digestive tract, and oxygen from the lungs. The food products are in the form of solutions and emulsions, and are absorbed by the veins and lymphatics. Their evolution into blood and tissue pabulum is carried on while circulating in the vessels and passing through the various organs, as the spleen, liver, red marrow of bones, etc. The capillaries serve as the ultimate distributers of the renovated blood to the tissues, which assimi-

late the new and give up the old. From the intercellular and lymph spaces, this blood fluid, charged with waste products, is then taken up by the veins and lymphatics and passed to and through various excretory organs, as the lungs, skin, kidneys, liver, etc., which separate the effete materials to be cast off.

The blood makes a complete circuit of the body, on an average, in thirty-two or thirty-three seconds, or during twenty-seven heart-beats.

In the adult, the blood constitutes one-thirteenth part of the weight of the body; in the new-born infant, one-nineteenth.

Life is endangered by hemorrhage, in proportion to the amount and rapidity of the bleeding. In adults, when one-half the total blood is lost suddenly, death is liable to take place, and in newly born children, when a few ounces are lost. The old, the young, and the adipose bear the loss of blood badly.

## NERVOUS SYSTEM.

### SPINAL NERVES.

(A) *Cervical Plexus*, consisting of first four cervical nerves (1), (2), (3), (4).

(B) *Brachial Plexus*, consisting of (5) fifth cervical, (6) sixth cervical, (7) seventh cervical, (8) eighth cervical, and (9) first dorsal nerves.

(10) Second dorsal. (11) Third dorsal.

(C) *Lumbar Plexus*, consisting of (12) the first lumbar, (13) second lumbar, (14) third lumbar, (15) fourth lumbar, and the dorsi-lumbar cord.

(D) *Sacral Plexus*, consisting of (16) the fifth lumbar, (17) first sacral, (18) second sacral, (19) third sacral, and (20) part of fourth sacral.

(21) Fifth sacral. (22) Coccygeal.

(a) Phrenic — internal respiratory.

(b) Long thoracic — external respiratory.

(c) Spinal Cord.

(d) Brain.

(E) Method of communication of Spinal Nerves with Sympathetic, by a twig which is composed of white matter from the cord to the gangiion and gray matter from the ganglion to the cord.

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### CRANIAL NERVES.

(F) Olfactory.

(G) Optic.

(H) Motor Oculi.

(I) Patheticus.

(J) Tri-facial. (a) Ophthalmic division. (b) Superior maxillary division. (c) Inferior maxillary division. (e, h) Dental branches. (f) Branch to palate. (g) Lingual — special nerve of taste to tongue. (j) Supraorbital branch of ophthalmic division.

(K) Abducens.

(L) Portio dura — facial nerve — nerve of expression. (The Portio-mollis not shown.)

(M) Eighth nerve. (m) Glosso-Pharyngeal branch. (n) Pneumogastric branch. (p) Spinal Accessory branch.

(N) Hypoglossal nerve.

## SYMPATHETIC SYSTEM.

(I) Cervical portion: (1) Superior, (2) Middle, (3) Inferior Cervical Ganglia.
(II) Thoracic portion.
(III) Lumbar portion.
(IV) Sacral portion.
(V) Ganglion impar.

The Cephalic portion consists of four pairs of ganglia, namely, the ophthalmic, the spheno-palatine, the optic and the submaxillary — all in connection with the fifth cranial nerve, but communicating freely with the other cranial nerves.

The Sympathetic System has a double chain of ganglia, placed on each side of the bodies of the vertebræ. In the thorax they lie in front of the heads of the ribs. The ganglia correspond mostly with the vertebræ, and the divisions of the latter into regions. Each has a branch of communication with the spinal nerves — and all with each other — composed of white and gray matter.

These ganglia are the *lateral* or vertebral. They give off branches which go, chiefly, to the thoracic, abdominal, and pelvic cavities, forming the *collateral* or pre-vertebral ganglia, or centers, named the cardiac, the solar, and the hypogastric plexuses. From these gangliated plexuses, branches are again given off to form the *terminal* ganglia, or plexuses, which surround and accompany all the arteries of the viscera.

The sympathetic has independent functions, due to its own gray matter, such as are found in the automatic ganglia of the heart, the mesenteric plexus of the intestines, and those for the uterus, ureters, and walls of blood-vessels.

The dependent functions of the sympathetic are those which inhibit, augment, or modify impulses from the cerebro-spinal centers.

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## THE SPINAL CORD.

The *spinal cord* is that part of the central nervous system contained in the spinal canal, extending from the foramen magnum to the junction of the first and second lumbar vertebræ. It is fifteen to eighteen inches in length, and has a cervical and a lumbar enlargement. A median fissure, before and behind, divides it into symmetrical halves connected by a commissure. The gray matter is in the center, in the form of two crescents, placed with their convexities together, giving an anterior and a posterior horn for each lateral half. Around the gray matter, the white conducting matter is disposed as tracts or columns, between or through which the anterior and posterior roots of the spinal nerves pass to or from the horns of the gray matter.

The spinal cord is, first, a conducting medium; second, a center, or centers, for reflex action; third, for automatic impulses. It conducts outgoing impulses as motor to muscles, vaso-motor to blood-vessels, secretory to glands, trophic to the tissues. The paths for the outgoing impulses are, chiefly, the motor tracts from the brain — the direct pyramidal in the anterior median part, and the crossed pyramidal in the posterior part of the lateral columns. Fibers from these tracts pass to and through the cells of the anterior horn of each segment to the anterior roots of the spinal nerve. Hence the motor tracts diminish in size from above downward. It also conducts in-going impulses, causing *general* sensations — cutaneous, articular,

muscular, visual; *special* sensations — tactile, pain, heat, exciting reflex and automatic centers. These in-going impulses come from the periphery — through the posterior roots of the spinal nerves, to and through the cells in the posterior horns of the gray matter, and thence upward through the *sensory tracts* — the posterior median and the posterior lateral columns. The sensory tracts increase in size from below upward. Impulses are also conducted, from one segment to another, through the " association tracts " — the anterio-lateral column — which are of uniform size throughout the cord.

A center for a spinal reflex is that part of the gray matter which transfers a stimulus from the in-going fiber of the posterior root to the out-going fibers of the anterior root, constituting the middle part of the reflex arc.

The spinal reflexes are the superficial or *cutaneous*, the deep or *tendon reflexes* and the *organic*. The cutaneous reflexes are the *plantar*, the *cremasteric*, the *gluteal*, the *abdominal*, the *epigastric* and the *interscapular*. The deep reflexes are the *knee-jerk*, the *jaw-jerk*, the *ankle clonus*, and the *abdominal reflex*. The organic reflexes are concerned in the acts of respiration, circulation, secretion, micturition, defecation, etc.

The automatic centers of the cord are those which retain their activity after being separated from the medulla, but, normally, are subject to the control of the higher centers of the medulla and cerebrum, and are subordinates to these. Examples are the cilio-spinal center for dilating the pupil (opposite the lower cervical and the upper two dorsal vertebræ); the ano-spinal center in the lower lumbar segments; the vesico-spinal about the fourth or fifth lumbar; the vaso-motor centers; the sweat centers.

A segment of the spinal cord is that portion of its entire thickness which corresponds to the origin of a pair of spinal nerves. There are, hence, thirty-one segments, each of which has its own special functions as a nerve center, and also functions for transmitting and modifying impulses from other segments and distant centers.

Each of the thirty-one pairs of spinal nerves has two roots of origin from the cord — a posterior, afferent or sensory root, with a ganglion of gray matter, and an anterior, efferent, or motor root. The two roots join at the intervertebral foramen, forming a compound nerve, which then separates into an anterior and a posterior division, or ventral and dorsal, each of which has special relations — the dorsal supplying the structures about the spinal column. They are smaller than the ventral, except those of the first and second — the sub-occipital and the great occipital — which supply the back part of the scalp.

The ventral divisions supply all the anterior parts of the body. Those for the limbs join and intermingle so as to form plexuses. The ventral plexus for the upper limb is derived from five spinal nerves, while the lumbo-sacral plexus for the lower limb is derived from nine.

As a general rule, a particular nerve trunk supplies those parts which are associated in function — as the muscles which move a joint (muscular branch), the joint itself (articular branch), the skin about the joint and insertion of the muscles (cutaneous branch).

The roots of the first cervical nerve pass slightly upward in the canal to reach the foramen of exit. Those of the second pass horizontally, while all others pass downward in the canal to reach the foramen of exit, the spinal canal being much larger than the cord.

The origins of the nerves in the spinal cord have the fol-

lowing relations to the spinous processes of the vertebræ:

First cervical — level of foramen magnum.

Second cervical — a little below occipital bone.

Third cervical — middle of space between occipital bone and spinous process of axis.

Fourth cervical — spine of axis.

Fifth cervical — spine of third vertebra.

Sixth cervical — between third and fourth spines.

Seventh cervical — from spine of fourth to spine of fifth.

Eighth cervical — below spine of fifth vertebra.

First dorsal — spine of seventh cervical vertebra.

Second dorsal — seventh cervical to first dorsal vertebra.

Third dorsal — first dorsal vertebra and below.

Fourth dorsal nerve — second dorsal vertebra.

Fifth dorsal — third dorsal vertebra.

Sixth dorsal — fourth dorsal vertebra.

Seventh dorsal — fifth dorsal vertebra and above.

Eighth dorsal — from fifth to sixth dorsal vertebra.

Ninth dorsal — from sixth to seventh dorsal vertebra.

Tenth dorsal — from seventh to eighth dorsal vertebra.

Eleventh dorsal — from eighth to ninth dorsal vertebra.

Twelfth dorsal — from ninth to eleventh dorsal vertebra.

The *five lumbar* nerves arise from between spines of eleventh and twelfth dorsal vertebræ. The *five sacral* and the *coccygeal* arise from level of the spine of twelfth dorsal to first lumbar. The cord terminates at lower border of first lumbar vertebra.

Hence any lesion which paralyzes the neck and upper limbs must be above the fifth cervical vertebra. The phrenic nerve — a part of the third and fourth — is affected only when the lesion is at or above the axis. A lesion at the sixth or seventh cervical paralyzes all the intercostal muscles; at the third dorsal, all spaces below the third are

affected; at the fifth dorsal, the abdominal walls; at the eleventh dorsal, the lumbar and sacral plexuses become involved; at the twelfth dorsal, the sacral plexus is paralyzed.

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*(For the Brain, see description of the Head.)*

# THE BODY AND EXTREMITIES.

## INDEXES TO SECTIONS.

### MUSCLES OF THE ANTERIOR PART OF THE BODY.

(d) Isthmus of the Thyroid gland, covering the upper part of the Trachea.
(f) Clavicle.
(g) Manubrium of Sternum.
(h) Central part of Sternum (Gladiolus).
(i) Coracoid process of Scapula.
(k) Acromion process.
(l) First rib. (m) Second rib. (n) Third rib.
(o) Fourth rib. (p) Fifth rib.
(r) Head of Humerus (greater tuberosity).
(s) Interclavicular ligament.
(t) Rhomboid ligament.
(u) Aponeurosis of External Intercostals.
(v) Acromio-clavicular ligament.
(w) Coraco-acromial ligament.
(17) Platysma-Myoides — a cutaneous muscle, the upper end of which is one of the muscles of expression.
(18) Sterno-mastoid (sternal portion).
(19) Sterno-hyoid.
(20) Scalenus Anticus.
(21) Pectoralis Major.

(22) Pectoralis Minor.

(23) Subclavius.

(24) Serratus Magnus — interdigitating with (25) External Oblique of the abdomen.

(26) Linea Alba.

(27) Rectus. (28) Its transverse aponeuroses (Linea Transversæ).

(29) Pyramidalis.

(30) Internal Oblique.

(31) Poupart's Ligament, or Crural Arch, composed of the thickened lower border of the aponeurosis of external oblique. Below it, is the Saphenous opening — the outer end of the Femoral canal, through which comes Femoral Hernia.

(32) External boundary (Pillar) and (33) internal boundary (Pillar) of (34) external abdominal ring, which is an opening in the aponeurosis of external oblique, caused by divergence of its fibers. The lower boundary of the ring is the crest of the Pubes.

(35) Internal abdominal ring, the opening in transversalis fascia, situated a half-inch above Poupart's ligament, and midway between spines of the Pubes and Ilium.

(36) Inguinal canal for the spermatic cord, and through which oblique inguinal hernia makes its way. Its roof is the conjoined lower border of internal oblique and transversalis muscles; its floor, Poupart's ligament; its outer wall, the aponeurosis of external oblique; its inner wall, the transversalis fascia, upon which the number 36 is placed.

(37) Border of Deltoid muscle.

(38) Coraco-Brachialis.

(39) Short head, and (40) long head, of biceps.

## THE THORAX.

(5) Clavicle.

(6) Sternum. (6) Manubrium. (6′) Gladiolus. (6″) Ensiform Cartilage.

(7) Ribs.

(8) Costal Cartilages—those of the false ribs—eighth, ninth and tenth—join that of the seventh.

(9) Sterno-Clavicular joint with ligaments, and (9′) without.

(10) Costo-Sternal joint with ligament.

(11) Inter-clavicular notch.

(12) Internal and (12′) External Intercostal muscles—the analogues of the oblique muscles of the abdomen. The external are aponeurotic from the sternum to the ends of the costal cartilages, and both are aponeurotic from the angles of ribs to spine. Between these two muscular planes, in an osteo-fibrous canal on the under border of each rib, are the intercostal muscles and nerves.

(13) (13′) Costal (Parietal) Pleuræ.

## MEDIASTINUM AND LUNGS.

(14) Mediastinum—the space from before backward, from sternum to spine, bounded laterally by the Pleuræ. Nothing but the cellulo-adipose tissue is shown. The space is divided into the *anterior* (from the sternum to pericardium), which contains the remains of the Thymus gland, Triangularis Sterni muscle, left Brachio-Cephalic vein (crossing behind first part of sternum), Lymphatic glands

and left internal Mammary artery and vein; the *middle*, which contains the heart with its large vessels and Phrenic nerves; and the *posterior*, containing the Œsophagus, Pneumogastric nerves, Aorta, Thoracic Duct, Azygos vein, Trachea and Lymphatic glands.

(15) (15) Upper and lower lobes of left lung.

(16) (16) (16) Upper, middle and lower lobes of right lung.

INTERIOR OF LUNGS.

(17) Trachea.

(A) Arch of Aorta.

(B) Pulmonary artery, which begins in front of root of aorta and bifurcates under its arch, giving a branch to each lung. It conveys venous blood from the right ventricle to the lungs.

(C) Superior Vena Cava, emptying into right auricle.

(D) One of Left Pulmonary veins, there being two on each side which convey the purified blood from the lungs to the left auricle, by four openings.

THE HEART.

(a) Right Auricle.

(b) Right Auricular appendage.

(c) Left Auricle.

(d) Left Auricular appendage.

(e) Mitral (Left Auriculo-Ventricular) valve.

(f) Tricuspid (Right Auriculo-Ventricular) valve.

(g) Musculi Papillares, with the free ends of which the flaps of the valves are connected by (h) the Chordæ Tendinæ.

(i) Ventricular Septum.

(14) Loop of large intestine (Sigmoid Flexure of Colon).

(15) Bladder.

(16, to the left.) Great Omentum with Omental vessels, branches of the Gastric.

(16, to the right.) Transversalis fascia and subperitoneal fat, in which are imbedded (C′) the deep epigastric vessels — the artery, a branch of the external iliac, passing upward and inward to reach the sheath of the rectus muscle, in which it passes upward to anastomose with the superior epigastric, the terminal branch of the internal mammary. In obstruction of the abdominal or thoracic aorta, collateral circulation is carried on largely by this circuit. The veins (the inner one the larger) passing down, join the external iliac.

(17) Fold of Peritoneum — Median Vesical ligament. (a2) Parietal Peritoneum.

(X) Spermatic artery and vein.

THE LIVER.

(1) Right lobe — lower surface.

(2) Left lobe.

(3) Gall-bladder distended, which normally projects from under the ninth costal cartilage. When distended, and the liver is enlarged, it approaches the umbilicus.

(4) Portal vein subdividing.

(5) Hepatic veins uniting to join the vena cava as it lies in its groove on posterior border of liver.

(6) Common bile duct, between which and the Portal vein, is the Hepatic artery — a branch of the Cœliac axis.

(8) Hepatic duct, joining (8) the Cystic duct, to make the common duct.
(9) Neck of gall-bladder.
(10) Cystic artery.
(11) The Round ligament — the remains of the umbilical artery, lying in the longitudinal fissure between the double fold of peritoneum (12), called the Falciform or Suspensory ligament.

STOMACH AND INTESTINES.

(1′) Œsophageal opening of stomach.
(3) Cardiac end of stomach and interior wall.
(3′) Rugæ of mucous membrane.
(4) Pylorus.
(5) Beginning of Duodenum.
(7) Jejunum and Ileum.
(8) Vermiform Appendix.
(9) Cæcum (Caput Coli).
(10) Ascending Colon.
(11) Hepatic Flexure.
(12) Transverse Colon.
(13) Splenic Flexure.
(14) Descending Colon, terminating in the Sigmoid Flexure.
(15) Bladder distended.

SECTION OF BODY, AND SHOULDER AND HIP JOINTS.

(1) Superior Constrictor muscle of Pharynx.
(2) Middle.
(3) Inferior.
(4) Mucous membrane of Pharynx.
(5) Clavicle.
(6) Acromio-Clavicular ligament.

(7) Ribs.
(8) Acromion process of Scapula.
(9) Coraco-acromial ligament.
(10) Tendon of long head of Biceps.
(11) Capsular ligament.
(12) Anterior or inner surface of external Intercostal muscles.
(12′) Internal surface of internal Intercostals.
(13) Scapula.
(14) Head of Humerus, the lesser tuberosity of which looks directly forward.
(15′) Surgical neck of Humerus, which extends from tuberosities to lower border of axilla.
(16) Coracoid process of Scapula.
(17) Articular Cartilages of head of Humerus and Glenoid Fossa.
(18) Spleen.
(19) Pancreas.
(20) Right kidney.
(20′) Pyramidal substance of kidney.
(21) Supra-renal Capsule.
(22) Pelvis.
(22′) Calyces.
(23) Cortical substance.
(24) Ureter.
(25) Transversalis muscle.
(26) Psoas.
(27) Iliacus Internus.
(28) Pyriformis, the anterior border being continuous with the Coccygeus, forming the floor of the Pelvis.
(29) Sacrum.
(30) Sacro-Iliac ligament.

(31) Capsular ligament of hip joint. It is re-enforced, on the anterior surface, by (32) the inverted "Y" or Ilio-Femoral ligament, which arises from the anterior-inferior spine of Ilium, and is inserted into (33) the intertrochanteric line of Femur.

(34) Outer surface Great Trochanter.

(35) Tuberosity of Ischium.

(36) Anterior pubic ligament.

(37) Obturator membrane.

(38) Pectineal eminence.

(39) Crest of Ilium, ending below in the anterior superior spine.

(40) Section of rim of Acetabulum, and articular cartilage.

(41) Synovial sac of hip joint.

(42) Lesser Trochanter.

(A) Aorta.

(E) Inferior Vena Cava.

(F) Right and left common Iliac arteries.

(F′) Internal Iliac.

(F″) External Iliac.

(G) Left common Iliac vein.

(G′) Left external Iliac vein.

(H) Common Femoral artery.

(H′) Superficial Femoral.

(H″) Deep Femoral.

(1) Right Azygos vein, which takes the place of the vena cava within the chest, receiving all the right intercostal veins, and, after arching over the right bronchus, empties into the superior vena cava. It communicates with the inferior cava at its beginning, either directly or indirectly. It is joined by the left azygos about the middle of the chest.

(k) Subclavian artery, terminating at the lower border of the first rib, in the axillary, which terminates in (1) the brachial, at the lower border of the teres major muscle.
(m) Acrominal Thoracic.
(n, n′) Short and Long Thoracic.
(o) Subscapular — giving off dorsalis scapulæ.
(p) Anterior and (q) Posterior Circumflex.
(r) Superior Profunda.
(s) Branches of Transversalis Colli.
(t) Intercostal arteries and veins.
(u) Splenic artery.
(v) Renal artery.
(v′) Lumbar artery.
(w) Renal vein.
(x) Spermatic artery and vein.
(y) Inferior Mesenteric.
(a′) Lumbar artery and vein.
(b′) Superior Gluteal.
(b2) Ilio-lumbar.
(c′) Deep Epigastric.
(d′) Circumflex Iliac.
(e′) Sciatic and Internal Pudic.
(f′) External Circumflex.
(g′) Obturator.

## UPPER EXTREMITY.

### PLATE 1.

*Arm.* — (1) Acromion process. (12) Fascia of pectoralis muscle. (13) Deep fascia of arm. (18) Deltoid muscle covered with fascia. (19) Pectoralis major muscle. No arteries except small muscular (B) or cutaneous branches are shown. (I) Subcutaneous veins. (II) Basilic vein.

(III) Cephalic vein. (IV) Median and median cephalic veins. (a) Supraclavicular nerve. (b) Posterior cutaneous, from the circumflex. (c) Branches from the anterior thoracic. (d) Internal cutaneous. (e) Lesser internal cutaneous. (h) Musculo-cutaneous.

*Fore-arm and Hand.* — (9) Deep fascia. (10) Bicipital fascia. (11) Palmar fascia. (11′) Transverse palmar ligament. (12) Anterior annular ligament. (14) Panniculus adiposus of the fingers. (29) Palmaris brevis muscle. (III) Cephalic or radial vein. (IV) Median vein. (V) Median Basilic vein. (a) Branches of internal cutaneous nerve (b) Same. (c) Branches of musculo-cutaneous nerve. (i) Palmar branch of ulnar nerve. (m) External cutaneous branch from musculo-spinal nerve.

### PLATE 2.

*Arm.* — (1) Acromial end of clavicle. (2) Coracoid process of scapula. (3) Greater tuberosity of head of humerus. (4) Lesser. (5) Bicipital groove. (8) Coraco-clavicular ligament. (9) Coraco-acromial ligament. (10) Capsular ligament. (15) Bicipital fascia. (16) Pectoralis major tendon. (17) Triceps muscle. (19) Pectoralis major. (20) Biceps. (20′) Short head of biceps. (20″) Long head of biceps. (21) Coraco-brachialis muscle. (22) Brachialis anticus muscle. (23) Triceps muscle. (A) Brachial artery. (D) Inferior profunda. (III) Cephalic vein. (IV) Median Cephalic. (V) Venæ comites — brachial. (VI) Beginning of Cephalic.

*Fore-arm and Hand.* — (1) Internal condyle of humerus. (9) Deep fascia. (10) Aponeurosis of biceps muscle. (11) Palmar fascia. (12) Anterior annular ligament. (13) Sheaths of flexor tendons — circular and oblique fibers. (15) Biceps muscle. (15) Inferior bicipital tendon. (16)

Brachialis anticus muscle. (17) Triceps. (18) Supinator longus. (22) Flexor carpi radialis. (23) Palmaris longus. (24) Flexor sublimis digitorum. (27) Flexor carpi ulnaris. (28) Pronator quadratus. (29) Palmaris brevis. (30) Abductor pollicis. (31) Opponens pollicis. (32) Flexor brevis pollicis. (33) Adductor pollicis. (34) Abductor minimi digiti. (35) Flexor brevis minimi digiti. (36) Lumbricales. (B) Radial artery. (G) Ulnar artery, forming the superficial palmar arch. (K) Digital branches. (N) Superficial radial nerve. (N″) Dorsal branch.

PLATE 3.

*Arm.* — (1) Acromio-clavicular joint. (2) Coracoid process. (3) Greater tuberosity of head of humerus. (4) Lesser. (11) Sheath of biceps tendon. (16) Insertion of pectoralis major muscle. (17) Insertion of deltoid. (18) Deltoid. (20′) Long head of biceps. (20″) Short head. (21) Coraco-brachialis. (22) Brachialis anticus. (23) Triceps. (A) Brachial artery. (B) Muscular branches. (C) Superior profunda. (D) Inferior profunda. (d) Internal cutaneous nerve. (f) Median nerve. (g) Ulnar. (h) Musculo-cutaneous.

*Fore-arm and Hand.* — (1) Internal condyle. (2) Radius. (3) Ulnar. (4) Pisiform bone. (5) Unciform bone. (6) First phalanges. (7) Second. (8) Third phalanges. (15) Biceps tendon. (16) Brachialis anticus. (19) Extensor carpi radialis brevior. (20) Supinator brevis. (24) Flexor sublimis digitorum. (26) Flexor longus pollicis. (28) Pronator quadratus. (31) Opponens pollicis. (32) Flexor brevis pollicis. (33) Adductor pollicis. (34) Abductor minimi digiti. (35) Flexor brevis minimi digiti. (37) Interossei. (A) Brachial artery. (B) Radial. (C) Superficial volar branch. (D) Dorsal branch. (E) Ulnar

artery. (F) Interosseous. (G) Superficial branch for superficial palmar arch. (K) Digital branches. (V) Venæ comites. (d) Median nerve. (d′) Muscular branch. (e) Internal interosseous. (g) Digital branches. (k) Ulnar nerve. (k, k′) Digital and muscular branches. (l) Radial nerve. (n) Superficial radial. (n′) Anterior. (n″) Posterior branches.

### PLATE 4.

*Arm.*—(2) Acromion process. (2′) Coracoid process. (3) Clavicle. (4) Greater tuberosity. (11) Capsular ligament. (12) Sheath of biceps tendon. (20) Long head of biceps. (24) Internal head of triceps muscle. (24″) External head of triceps. (24‴) Middle or scapular head of triceps. (A) Axillary artery. (B) Brachial artery. (C′) Acromial branch of transverse scapular artery. (D) Thoracic branch of brachial artery. (E) Acromial thoracic. (F) Long thoracic branch. (G, G′) Subscapular artery and branches. (H) Anterior circumflex. (I) Posterior circumflex. (K) Muscular branches. (L) Superior profunda. (M) Inferior profunda.

*Fore-arm and Hand.*—(16) Anterior ligament, elbow joint. (18) External lateral ligament. (18′) Part of orbicular ligament. (20) Interosseous ligament. (5) Styloid process of ulna. (7) Styloid process of radius. (8) Pisiform bone. (9) Unciform bone. (10) Trapezium. (11) Carpo-metacarpal joint of thumb. (12) Metacarpal. (13) First phalanges. (14) Second phalanges. (15) Third phalanges. (16, 18, 18′) Ligaments of elbow joint. (31) Pronator radii teres. (32) Supinator brevis muscle. (33) Flexor carpi radialis. (34) Pulmonis longus. (35) Flexor sublimis digitorum. (36) Flexor profundis digitorum. (37) Flexor longus pollicis. (38)

Pronator quadratus. (39) Adductor pollicis. (40) Abductor minimi digiti. (41) Palmar interosseous. (B) Radial artery. (D) Dorsalis pollicis. (G) Ulnar. (G′) Ulnar recurrent. (H) Interosseous. (I) Metacarpal branch. (K) Termination of ulnar, which is continued as the superficial palmar arch.

PLATE 5.

*Arm.*— (2) Acromion. (3) Clavicle. (22) Coracoid process. (4) Greater tuberosity of the head of humerus. (12) Sheath of biceps tendon. (19) Insertion of pectoralis major. (20) Biceps tendon, long head. (21) Short head. (22) Coraco-brachialis. (23) Brachialis anticus. (24) Triceps muscle. (A) Axillary artery. (B) Brachial. (F) Long thoracic. (G, G) Subscapular and its branches. (H) Anterior circumflex. (I) Posterior circumflex. (K) Muscular branches. (L) Superior profunda. (M) Inferior profunda. (N) Anastomotica magna.

*Fore-arm and Hand.*— (2) External condyle of humerus. (4) Ulna. (6) Radius. (7) Styloid process of radius. (8) Pisiform bone. (9) Unciform. (10) Trapezium. (11) Trapezoid. (12) Metacarpal. (13, 14) Phalanges of thumb. (16) Anterior ligaments. (20) Interosseous ligaments of elbow joint. (22, 23, 24) Ligaments of wrist joint. (30) Tendon of biceps — insertion. (31) Pronator radii teres. (32) Supinator brevis. (36′) Tendons of flexor sublimis digitorum. (38) Pronator quadratus. (41) Interosseous. (A) Brachial artery, lower end. (B) Radial artery. (C) Superficialis volæ. (D) Dorsal branch of radial. (D′, D″) Dorsal branches to thumb. (E) First digital branch. (E′, E″) Branches to ulnar and radial sides of thumb (princeps pollicis). (F) Deep palmar branch. (G) Ulnar artery. (G′) Ulnar recurrent interos-

seous. (H′) Anterior interosseous. (I) Dorsal branch. (K) Ulnar, dividing into deep and superficial branches; the superficial joining (C) to form (K) the superficial palmar arch — the deep branch joining from the radial to form (L′) the deep palmar arch. (M) Digital branch to little finger. (N) Common digital branches. (O) Interosseous arteries. (P) Digital.

PLATE 6.

*Arm.*— (2) Coracoid process. (3) Clavicle. (4) Greater tuberosity of humerus. (9) Coraco-clavicular ligament. (10) Coraco-acromial. (11) Capsular ligament. (12) Sheath of biceps tendon. (16) Anterior ligament of elbow joint. (17, 18) Lateral ligaments. (20) Long tendon of biceps. (18′) Orbicular ligament. (A) Position of axillary artery. (D′) Long thoracic. (E) Anterior thoracic. (F) Subscapular. (G) Internal cutaneous of arm (G′) Posterior branch. (H) Middle cutaneous. (H′) Ulnar cutaneous branch. (I) Musculo-cutaneous nerve. (K) Circumflex. (L) Posterior cutaneous of arm. (M) Median nerve. (N) Ulnar nerve. (O) Muscular spiral. (O′) External cutaneous branch.

*Fore-arm and Hand.*— (1) Internal condyle of humerus. (2) External. (3) Internal part of trochlear surface of humerus. (4) Ulna. (5) Styloid process. (6) Radius. (6′) Neck of radius. (6″) Bicipital tuberosity. (7) Styloid process of radius. (8) Pisiform bone. (9) Unciform bone. (10) Scaphoid. (11) Trapezium. (12) Metacarpus. (13, 14, 15) Phalanges. (19) Oblique ligament. (20) Interosseous membrane. (21, 24) Straight and oblique volar ligaments. (22, 23) Lateral ligaments. (25, 26) Anterior carpal ligaments. (27, 28, 29, 30) Carpal, metacarpal and transverse ligaments. (a) Lesser

internal cutaneous nerve. (b′) Palmar branch. (b″) Ulnar cutaneous branches. (c) Musculo cutaneous. (d) Median nerve. (d′) Muscular branches. (e) Interosseous branch. (f) Long palmar. (g) Digital branches. (h) Ulnar nerve. (i) Dorsal branch. (k) Palmar branch. (k′) Superficial palmar branch. (k″) Digital branches. (k‴) Deep ulnar branch. (l) Radial. (l′) External cutaneous branch. (m) Posterior branch. (n) Anterior. (n′) Dorsal branch of thumb

## LOWER EXTREMITY.

### PLATE 1.

*Thigh.*— (1) Patella. (5) Fascia lata. (6) Crural fascia. (8) Bursa patellæ. (I) Internal saphenous vein. (II) Subcutaneous veins. (a) External cutaneous nerve. (b) Branch of genito-crural nerve. (c) Branch of inguinal. (e) Internal cutaneous nerve. (f) Middle cutaneous.

*Leg.*— (2) Internal malleolus. (4) External malleolus. (6) Deep fascia of the leg. (7) Anterior annular ligament. (8) Dorsal fascia of the foot. (I) Subcutaneous veins. (II) Long saphenous vein. (a) Long saphenous nerve. (b) Musculo-cutaneous. (c) Cutaneous branches of external popliteal. (d) Internal cutaneous of the dorsum of foot. (e) Middle cutaneous of dorsum. (g) Digital nerves.

### PLATE 2.

*Thigh.*— (1) Patella. (2) Internal condyle of femur, (3) of tibia. (9) Sartorius muscle. (10) Rectus muscle. (11) Vastus internus. (12) Vastus externus. (14) Pectineus muscle. (15) Adductor longus. (17) Gracilis. (I) Long saphenous vein. (II) Subcutaneous veins. (e) Branches of internal cutaneous nerve.

*Leg.*— (1) Tibia. (2) Internal malleolus. (3) Fibula. (4) External malleolus. (5) Metatarsal. (7) Anterior annular ligament. (9) Tibialis anticus. (10) Extensor digitorum longus. (10′) Peroneus tertius. (11) Extensor brevis digitorum. (14) Extensor hallucis longus. (13) Peroneus longus. (14) Peroneus brevis. (15) Gastrocnemius. (16) Soleus. (17) Abductor hallucis. (18) Interosseous. (A) Anterior tibial artery. (A′) Dorsalis pedis artery. (III) Deep veins of leg.

**PLATE 3.**

*Thigh.*— (1) Patella. (2) Internal condyle of femur. (3) Of tibia (5) Deep fascia. (9) Sartorius muscle. (10) Rectus muscle. (11) Vastus internus. (12) Vastus externus. (13) Psoas and internal iliac muscles. (14) Pectineus. (15) Adductor longus. (16) Adductor magnus. (17) Gracilis. (A) Femoral artery. (B) Deep femoral. (C) Muscular branches. (I) Internal saphenous vein. (c) Branch of ilio-inguinal nerve. (e) Branches of internal cutaneous. (f) Middle cutaneous. (g) Saphenous branches. (h) Muscular branches of crural nerve. (i) Musculo-cutaneous branches of crural nerve.

*Leg.*— (1) Tibia. (2) Internal malleolus. (4) Externa malleolus. (5) Metatarsal bones. (6) Fascia. (7) Anterior annular ligament. (9) Tibialis anticus tendon. (10) Extensor longus digitorum. (11) Extensor brevis digitorum. (12) Extensor hallucis longus. (13) Peroneus longus. (14) Peroneus brevis. (15) Gastrocnemius. (16) Soleus. (17) Abductor hallucis. (18) Interosseous. (b) Musculo-cutaneous nerves. (d) Dorsal cutaneous of foot. (e) Middle dorsal cutaneous. (f) Terminal branch of external saphenous. (g) Digital branches. (h) An-

terior tibial. (h′) Internal. (h″) Internal branches of same.

PLATE 4.

*Thigh.*— (1) Femur. (2) Internal Condyle. (3) External Condyle. (4) Patella. (13) Gracilis muscle. (14) Adductor longus muscle. (15) Adductor brevis. (16) Adductor magnus. (17) Insertion of pectineus muscle. (A) Femoral artery. (B) Deep femoral. (D′)First perforating artery. (F) Muscular branches. (5) Tuberosity of tibia. (7) Ligamentum patellæ (middle part). (8) Internal lateral part. (9) Internal lateral ligament. (10) External lateral ligament (anterior part). (10′) Posterior part. (11) Synovial capsule.

*Leg and Foot.*— (1) Tibia. (2) Internal malleolus. (3) Fibula. (4) External malleolus. (5) Tarsus. (6) Metatarsus. (7) First phalanges. (8) Second phalanges. (9) Anterior annular ligament. (10) Interosseous membrane. (10′) Tibio-fibular ligament. (10″) Superior external malleolar ligament. (11) Internal lateral or deltoid ligament. (13) External lateral ligament (anterior part). (14) Transverse metatarsal ligaments. (15) Capsular and lateral ligaments. (16) Peroneus longus and brevis muscles. (17) Tendons of extensor longus digitorum muscle, (18) of extensor longus pollicis, (19) of tibialis anticus. (20) Dorsal interosseous muscle. (A) Anterior tibial. (A′) Dorsalis pedis.

PLATE 5.

*Thigh.*— (1) Femur. (2) Internal condyle. (3) External condyle. (4) Patella. (7) Ligamentum patellæ. (8) Lateral ligament of patella. (9) Internal lateral ligament of knee joint. (10) External lateral ligament (anterior part). (10′) Posterior part. (11) Synovial capsule. (16) Adductor magnus. (17) Insertion of pecti-

neus muscle. (A) Femoral artery. (B) Profunda femoris. (C) Descending branch of external circumflex artery. (D′) First perforating. (D″) Second perforating. (D‴) Third perforating. (E) Nutrient artery of femur. (F) Muscular branches. (G) Anastomotica magna. (H) Popliteal. (I) Muscular branches. (K) Superior external auricular. (L) Superior internal auricular. (M) Middle articular. (N) Sural branches. (O) Inferior external articular. (P) Inferior internal articular branches. (Q) Anterior tibial.

*Leg and Foot.*—(1) Tibia. (2) Internal. (3) External malleolus. (4) Fibula. (5) Tarsus. (6) Metatarsus. (7) First phalanges. (8) Second phalanges. (10) Interosseous membrane. (10′) Tibio-fibular ligament. (10″) Superior external malleolar ligament. (11) Internal lateral or deltoid ligament. (12) Astragalo-scaphoid. (13) Anterior external lateral. (13′) Middle external lateral. (14) Transverse metatarsal. (15) Capsular ligaments. (A) Anterior tibial artery. (A′) Dorsalis pedis. (B) Recurrent tibial. (C) External malleolar. (C′) Internal. (D) External tarsal. (D′) Internal tarsal. (D″) Anterior tarsal. (E) Metatarsal. (F) Dorsal interosseous. (F′) Dorsalis hallucis. (F″) Deep plantar branch of same. (G) Posterior tibial. (H) Peroneal. (H′) Anterior peroneal. (K) Posterior internal malleolar. (K′) Posterior external. (L) Internal plantar. (L′) Internal superficial branch. (M) External plantar. (N) Superior plantar arch. (O) Sural branch.

### PLATE 6.

*Thigh.*—(1) Femur. (2, 3) Internal and external condyles. (4) Patella. (5′) Tuberosity of tibia. (6) Head of fibula. (7) Ligamentum patellæ. (8) Internal lateral

part. (9) Internal lateral ligament of knee. (10, 10′) External lateral ligament. (11) Synovial capsule. (a) Anterior obturator nerve. (b) Internal cutaneous. (c) Anterior internal cutaneous. (d) Long saphenous. (e) Great sciatic. (f) External popliteal or peroneal. (f′) Posterior cutaneous branches of leg. (i) Internal popliteal nerve. (k) Sural or long cutaneous nerve. (l) Anterior external cutaneous.

*Leg and Foot.*—(Figures refer to same as in preceding plate).—(a) Long saphenous nerve. (b) Musculo cutaneous or superficial peroneal. (c) Anterior cutaneous branches. (d) Internal cutaneous branch of foot. (e) Middle cutaneous branch. (f) Posterior external cutaneous of leg. (g) Digital branches. (h) Anterior tibial. (h′) Internal branch. (h″) External branch. (i) Posterior tibial. (k) External saphenous branch. (k′) External cutaneous branch. (l) Internal plantar. (m) External plantar. (n) Digital plantar.

# THE HEAD.

## THE SKULL, SCALP, ETC.

The skull, the bony part of the head, consists of the cranium and the face. Eight bones compose the former, and fourteen the latter. The immovable joints of the skull are called sutures (5), of which those of the vertex are the most important. These sutures are best named anatomically, as the fronto-parietal (*coronal*), the inter-parietal (*sagittal*), occipito-parietal (*lambdoid*). The average thickness of the flat bones of the cranium is one-fifth of an inch. The thickest parts are the occipital protuberance and at the parietal and frontal eminences. The temporal region is the thinnest. These flat bones have some peculiarities. The outer layer of "compact tissue" (external table) is thick and tough; the inner (internal table), thin and brittle. The cancellous tissue (*diploë*), most marked in middle life, is "intermediate like a soft leather cushion," and is channeled for numerous large veins with thin walls. The frontal, and part of the temporal groups of the diploic veins, discharge into the external veins of the head, while the occipital, and part of the temporal, discharge into the sinuses of the *dura-mater;* thus affording collateral relief for obstructed circulation of the brain by the intercommunication of the internal and external venous systems. This relation explains the serious brain symptoms which are liable to follow even a slight septic inflammation of the scalp and lesions of the cranial bones. Great vascularity characterizes the bones of the cranium and face, as well as all

the soft parts connected with them; hence the relatively quicker and more certain repair of injuries, or wounds.

There are three kinds of sinuses: Those of the dura mater for the return of the venous blood from the brain; the cerebral sinuses, which are interspaces between its lateral halves or other parts; and those in the bone, as the frontal, sphenoidal, etc., which contain air and communicate with the air passages.

There are five distinct strata of tissues covering the cranium; 1. The skin. 2. Dense fibro-adipose tissue, in which are the hair bulbs and the cutaneous vessels and nerves. The arteries, adhering to and firmly embedded in this tissue, when cut, do not contract or retract, and are with difficulty seized and drawn out with forceps; hence the free hemorrhage in scalp wounds and the trouble in arresting it. 3. The occipito-frontalis muscle, with its aponeurosis, which gives power to move the scalp, and which is, like the facial muscles, supplied by the facial nerve, and is classed as one of the muscles of expression. These three structures constitute the *scalp*, as the term is commonly used. 4. Loose areolar tissue, without fat, which allows "scalp" to glide freely on 5. The pericranium (external periosteum).

The remarkable vitality of the flaps in extensive wounds of the scalp is due not more to the free arterial supply and anastomosis than to the fact that the arteries are carried with the flap entering it from its base.

Cephalæmatoma is a blood tumor between the pericranium and the bone, and is limited to one bone. The ordinary effusion of blood (hæmatoma), as from a bruise, is in the loose areolar tissue between the aponeurosis and the pericranium. It is liable to be diffuse, but is not often large, because the vessels in this tissue are small. Wounds

of the scalp are not more prone to erysipelatous inflammation than other wounds. But phlegmonous inflammation (erroneously called erysipelas) does often occur if the wound is not properly treated. The loose areolar tissue is a favorable nidus for sepsis. The skin heals rapidly and confines septic secretions beneath, which diffuse rapidly. Drainage, keeping the angles of the wound open, and compression are most important in scalp wounds.

(1) Frontal bone
(2) Parietal.
(3) Occipital.
(4) Squamous portion of Temporal.
(5, 5) Fronto-parietal (Coronal) and Occipito-parietal (Lambdoid) sutures
(6) Malar.
(7) External Auditory Meatus.
(8) Orbicularis Palpebrarum muscle.
(9, 9) Zygomatici Major and Minor
(10) Masseter muscle.
(11) Orbicularis Oris.
(12) Levator Menti.
(13) Sterno-mastoid.
(14) Levator Anguli Scapulæ.
(15) Omo-hyoid — anterior part
(16) Internal Jugular vein.
(17) Facial vein.
(18) Temporal vein.
(19) Common Carotid artery.
(20) Facial artery.
(21) Superficial Cervical nerves
(22) Facial nerve.
(23) Supra-maxillary division.

(24) Trachea.
(25) Scalp.
(26) Skull.
(27) Cerebrum.
(28) Cerebellum.
(29) Spinal cord.
(30) Medulla Oblongata.
(31) Eyeball.
(32) Internal Rectus muscle.
(33) Optic nerve.
(34) Internal surface of Malar bone.
(35) Inferior Maxillary.
(36) Anterior Naris.
(37) Inferior Dental artery, and
(38) Nerve.
(39, 40) Cortex of Cerebrum, showing convolutions of gray matter.
(41) Corpus Callosum.
(42) Corpus Striatum.
(43) Optic Thalamus.
(44) Section of Cerebellum.
(45) Medulla Oblongata.
(46, 47) Outer wall of nasal cavity, showing the three turbinated bones and the meatuses — superior, middle and inferior — and the distribution of the olfactory nerve,
(48) The Hard palate — formed in front by the superior maxillary, and behind by the palate.
(49) Pharyngeal opening of Eustachian tube.
(50) Pharynx.
(51) Soft palate.

(52) Lateral portion of roof of mouth.

(53) Tongue.

(54) Sublingual gland.

(55) Epiglottis.

(56) Larynx.

(57) Junction of pharynx and œsophagus. This point is opposite the body of the fifth cervical vertebra (its lower border) and corresponds with junction of larynx and trachea.

(58) Body of fifth cervical vertebra.

(58′) Spinal process of vertebra.

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## THE BRAIN.

The gray matter of the brain is disposed as a layer on the outer surface — the cortex with its convolutions; as circumscribed convolutions in the basal ganglia — corpus striatum, optic thalamus, corpora quadrigemina; or, as the central gray tube continued up from the spinal chord through the medulla and pons around the iter to the tuber cinereum. The white matter connects these parts in various ways — either longitudinally or transversely — the corona radiata (1), (2), (3), (4), connecting the cortex with the basal ganglia; the commissural fibers (c, c) connecting corresponding parts of the two hemispheres; the association fibers (a, a) connecting different areas of the same part; the longitudinal bundle of fibers, as pyramids, tracts, etc., connecting the gray matter of the spinal cord with all the brain centers.

The ventricles of the brain are the spaces between the different ganglia or parts.

DIAGRAM OF THE RELATIONS OF THE CENTRAL GANGLIA OF GRAY MATTER TO EACH OTHER AND TO THE SPINAL CORD.

(C, C) Cortical gray matter of the cerebrum.
(C, S) Corpus striatum.
(N, L) Lenticular nucleus — the extra-ventricular part of former.
(T, o) Optic thalamus.
(V) Corpora quadrigemina.
(P) Peduncle of cerebrum.
(H) Tegmentum — the upper part of the peduncle.
(P) Crusta — under part of peduncle.
(1, 1) Corona radiata of corpus striatum.
(2, 2) Corona radiata of lenticular nucleus.
(3, 3) Corona radiata of the optic thalamus.
(4, 4) Corona radiata of the corpora quadrigemina.
(5) Direct fibers to cortex.
(6, 6) Fibers from corpora quadrigemina to tegmentum.
(7) Fibers of the optic thalamus.
(m) Same fibers continued.
(8, 8) Fibers from corpus striatum and nucleus to crusta.
(M) Same continued in cord.
(S, S) Course of sensory fibers.
(a, a) Association system of fibers.
(c, c) Commissural fibers.
(R) Transverse section of spinal cord.
(v, W) Anterior root.
(h, W) Posterior root.

LEFT SIDE OF THE BRAIN, SHOWING THE FISSURES, CONVOLUTIONS AND MOTOR AREAS, AND THEIR RELATION TO THE SKULL BONES AND THEIR SUTURES.

The outer surface of the cerebral hemispheres is divided into four lobes by the fissure of Sylvius, the fissure of Rolando, and the parieto-occipital fissure. These, from their depth, regularity, and early development, are called primary fissures. The frontal lobe is that part anterior to the fissure of Rolando. The parietal lobe is between the fissure of Rolando and the parieto-occipital fissure. The occipital lobe consists of that part of the hemisphere below the parieto-occipital fissure. The temporo-sphenoidal lobe is that part which occupies the middle fosse of the skull, and is bounded before and above by the fissure of Sylvius and joins the occipital behind. The Island of Reil, or central lobe — the fifth primary lobe — lies deep in the fissure of Sylvius, but does not show on the surface. Each of these primary lobes is subdivided, by secondary fissures, of more or less regularity, into secondary lobules called convolutions.

(K1) Bregma.

(K2) Parieto-frontal suture, crossing temporal ridge — the dotted semicircular line.

(K3) Anterior inferior angle of parietal, joining the sphenoid and frontal bones, and where the suture begins.

(M) Point on squamous suture crossed by a perpendicular line from depression in front of the meatus to the bregma.

(L1, L2) Parieto-occipital fissure.

The numbers (1) to (14) and the letters (a), (b), (c), (d), refer to cortical centers, and are the same as in description of following diagram.

(S) Main part of fissure of Sylvius, separating the frontal from the temporo-sphenoidal lobes. It divides into an ascending, or perpendicular, and a horizontal ramus. The latter is bisected at the point (M).

(C) Fissure of Rolando, or central sulcus.

(A) Ascending frontal convolution.

(B) Ascending parietal convolution.

(f 1) First or superior frontal fissure, corresponding to a curved line drawn parallel to the longitudinal fissure beginning at the supraorbital notch.

(f 2) Second or inferior frontal fissure, a little below, but nearly corresponding to the temporal ridge.

(f 3) Pre-central fissure — sometimes called an extension of the ascending ramus of the fissure of Sylvius. It corresponds to the parieto-frontal suture, and is frequently joined at right angles by (f 1) the first, (f 2) second, and (f 3) third frontal convolutions.

(i, p) Inter-parietal suture separating (P 1) superior parietal lobule or convolution from (P 2) inferior parietal lobule or convolution. The upper part of (P 2) is the supra-marginal convolution or gyrus, and the lower and posterior part is the angular convolution or gyrus.

(c, m) End of calloso-marginal fissure.

(P, o) Parieto-occipital fissure — the division between the parietal and occipital lobes — and nearly corresponding to the beginning of the occipito-parietal suture.

(L1, L2) Points on the parieto-occipital suture.

(o) Transverse occipital fissure.

(o 2) Inferior or longitudinal occipital fissure.

(O1, O2, O3) First and third occipital convolutions.

(t 1) First temporo-sphenoidal fissure — nearly parallel with horizontal branch of fissure of Sylvius, and nearly midway between it and

(t2) Second temporo-sphenoidal fissure.

(T1, T2, T3) First, second and third temporo-sphenoidal convolutions.

DIAGRAM OF UPPER SURFACE OF THE BRAIN.

This plate shows three of the primary lobes: the *frontal*, with its four subdivisions—the first, second, third, and ascending frontal convolutions; the *parietal*, with its four subdivisions—the ascending, superior, supra-marginal, and angular convolutions; the *occipital*, with its three convolutions—only the first and second appearing.

The figured and lettered circles are the cortical areas, mapped out on the surface, corresponding to various centers which have been located by the experiments and observations of Farrier and others.

The motor areas in general are in close relation to the fissure of Rolando, especially in the ascending frontal and parietal convolutions.

(1) On superior parietal lobule: centers for advancing opposite leg and foot, as in walking.

(2, 3, 4) Around upper end of fissure of Rolando: centers for complex movements of arms, legs and trunk combined, as in climbing and swimming.

(a, b, c, d) On the ascending parietal convolutions: the centers for fingers and wrist—prehensible.

(5) Posterior end of first frontal convolution: for reaching out the arm and hand.

(6) On the ascending frontal: for flexing and supinating forearm and hand—especially for the biceps.

(7, 8) Middle of same convolution: for elevation and depression of the angle of the mouth.

(9, 10) Broca's convolution—the *aphasiac* region: for movements of lip and tongue.

(11) Between (10) and lower end of the ascending parietal: retraction of angle of mouth—the *platysma*.

(12) Posterior parts of first and second frontal convolutions: for lateral movements of head and eyes, elevation of eyelids and dilatation of pupil.

(13, 13′) Supra-marginal and angular convolutions: centers of vision, with which the occipital lobe is also concerned.

(14) On superior temporo-sphenoidal: for center of hearing.

The center for smell is in the *hippocampal* lobule, not shown on the surface. Near by is the center of taste.

The center for sense of touch is in the hippocampal region and *gyrus fornicatus*.

## CRANIO-CEREBRAL TOPOGRAPHY—LANDMARKS AND RULES FOR LOCATING, ON THE SKULL OF THE LIVING SUBJECT, THE POSITION OF THE LOBES, PRINCIPAL BLOOD-VESSELS, FISSURES AND CONVOLUTIONS OF THE BRAIN.

(L) Lower border of orbit.

(E) External angular process.

(T) Beginning of temporal ridge.

(S) Supra-orbital notch.

(G) Glabella—prominence just above root of nose.

(B) Bregma—junction of inter-parietal and fronto-parietal sutures.

(+) Center of parietal protuberance.

(O) Occipital protuberance.

(M) Posterior border of mastoid.

(D) Depression in front of external auditory meatus.

(H L) Horizontal base line from lower border of orbit

through middle of meatus to the occiput. Plain lines indicate position of primary fissures. Dotted lines, the secondary fissures or sulci.

(a, b) Imaginary lines which arbitrarily mark the division between the parieto-occipital and temporo-sphenoidal lobes.

The *longitudinal fissure* corresponds to the curved line (G O), and separates the hemispheres of the cerebrum.

The *transverse fissure* (O D) is represented by a line from the occipital protuberance to the meatus, and corresponds to the superior curved line of the occipital bone, marking the separation of the occipital lobe from the cerebellum by the tentorium.

The *fissure of Sylvius* is indicated by a line starting one and one-fourth inches behind the external angular process of the frontal bone (E), and ending three-fourths of an inch below the center of the parietal protuberance (+). The first three-fourths of an inch is the main fissure, at the end of which it divides into the ascending branch, which extends upward an inch from the horizontal branch just given. The division is beneath the anterior inferior angle of the parietal bone. The motor speech center is just in front of the vertical branch of this fissure.

The *fissure of Rolando*. Draw the lines from (D) to the bregma (B) and from (M) to (F), perpendicular to the base line (H L). (F) can also be located by taking fifty-five and seven-tenths per cent. of the distance from (G) to (O). The fissure is represented by a line from (F) to the intersection of the fissure of Sylvius with the perpendicular line (D B).

The *parieto-occipital fissure* is an inch long and at right angles to the longitudinal fissure. It is one-fourth of an inch in front of the junction of the lambdoidal and inter-

parietal sutures, and is about twenty-three per cent. of the distance from (O) to (G). Also, if a line corresponding to the horizontal branch of the fissure of Sylvius were extended to the longitudinal fissure, the last inch would represent the parieto-occipital fissure.

These primary fissures divide the outer surface of the hemisphere into its four principal lobes, as follows. The *frontal lobe*, which is limited behind by the fissure of Rolando, and occupies the anterior fossæ of the bones of the skull. It has on its surface three secondary fissures or sulci. The *first frontal fissure* is parallel with the longitudinal fissure, and midway between it and the temporal ridge beginning at the supraorbital notch (S). The *second frontal fissure* is approximately represented by the temporal ridge on the frontal bone. The *precentral fissure* begins just above the upper end of the vertical branch of the fissure of Sylvius, and extends half way to the longitudinal fissure. It lies beneath the fronto-parietal suture, or just behind it. The frontal convolutions are found between these various fissures.

The *parietal lobe* is limited, in part, by the fissure of Rolando in front, and the parieto-occipital fissure behind. Of its four convolutions, the *ascending parietal* lies behind, and parallel with, the fissure of Rolando; the *supramarginal*, around the upper end of the horizontal branch of the fissure of Sylvius; beneath the parietal eminence, and a little below it, the perpendicular line (M F) separates it from the *angular convolution*.

The *inter-parietal fissure* is nearly indicated by a line starting on the fissure of Sylvius three-fourths of an inch behind the fissure of Rolando, running parallel with the longitudinal fissure, passing within one-half inch of the other end of the parieto-occipital fissure.

The *occipital lobe* is limited above by the parieto-occipital fissure extended as the curved line (a) to the end of the fissure of Sylvius. It is arbitrarily limited in front by the line (C) (b).

The *temporo-sphenoidal lobe* lies in the middle fossæ of the skull, and is bounded above by the fissure of Sylvius, its lower border corresponding to the zygoma, and a line continuing it to the superior curved line of the occipital bone. Its anterior limit is the posterior superior border of the malar bone. It is about one and five-eighths inches wide at the meatus.

The *first temporo-sphenoidal fissure* is parallel with the fissure of Sylvius, and an inch below it.

The *second temporo-sphenoidal fissure* is three-fourths of an inch below, and parallel with, the first.

The posterior limit of the *optic thalamus* corresponds to the perpendicular line (M F).

The anterior limit of the *corpus striatum* is a little in front of a vertical line from the beginning of the fissure of Sylvius.

Of the fifteen cerebral venous sinuses only two are in such relations to the skull as to be of practical importance in trephining for traumatic or pathological conditions.

One is the *longitudinal sinus*, which corresponds to the curved line (G) (O), but it is slightly to the left of the median line, and increases in width from before backward. The other is the *lateral sinus*, which is indicated by the line from (O) to the auditory meatus, and corresponds to the superior curved line of the occipital bone. It marks the inner surface of the tip of the posterior-inferior angle of the parietal bone. Hemorrhage from these sinuses is a serious complication of wounds, either operative or accidental, but, on account of the low blood-pressure in them,

is easily arrested by light pressure or fine cat-gut suture — the latter being difficult to apply in the midst of a free bleeding.

The *middle Meningeal* artery is the chief supply of the skull and dura mater, and is the only artery to be avoided in operations on the skull. The only part of it likely to be wounded is its main branch, which corresponds to the middle of the anterior-inferior angle of the parietal bone, ascending behind but nearly parallel with the fronto-parietal suture. The next large branch is horizontal, and corresponds nearly with the second temporo-sphenoidal fissure (which see). Hemorrhage from these branches is annoying, but usually not serious, as it can generally be arrested by the usual means — forci-pressure is often the best means. Still, they are to be avoided in operations, when possible.

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## THE EYE.

The organ of vision consists of the Globe and its protective organs, as the Eyelids and the Lachrymal Apparatus.

The eyelids are two elliptical structures consisting of strata of different tissues. The strata are :

I. The *skin*.

II. The *orbicularis muscle* (4), which closes the lids, is of thin, pale fibers, and supplied by the facial nerve as one of the muscles of expression. A thicker part of this muscle surrounds the borders of the orbit.

III. The *tarsal cartilage*, which is a rigid plate of connective tissue held in place by the tarsal ligaments, which extend from their outer border to the periosteum of the

orbit, and which prevent pus, in suppuration of the lid, from passing back into the orbit.

IV. The expanded tendon of the *levator palpebræ* (upper lid only).

V. *Meibomian* (*sebaceous*) *glands*, (2) whose ducts open on the free margins of the lid, (3) the fatty secretion of which prevents the overflow of tears.

VI. *Mucous membrane* (*conjunctiva*), which secretes some mucus, and forms the posterior layer of the eyelid.

The eyelids contain no fat, but the different strata are held together by delicate areolar tissue. The upper lid is the larger and more movable. The interval between the two lids is the *palpebral fissure*. The junction of the lids, at the ends of the fissure, makes the *inner canthus* and the *outer canthus*. Near the inner canthus each lid has a papilla, in which is a small opening to receive tears, the *punctum lachrymale* (5).

The tear apparatus consists of the *lachrymal gland* (1), situated below the external angular process of the frontal bone, and whose excretory ducts (eight to ten) perforate the conjunctiva on the under surface of the upper lid; the *puncta* (5), which are the outer openings of the *canaliculi* (6) (upper and lower), which join to form the *lachrymal sac*, from which passes downward (7) the *nasal duct*, opening into the *inferior meatus* of the nose, toward the front. The upper canaliculus first ascends vertically, dilates into a small pouch, and then runs, a quarter of an inch, transversely. The lower descends vertically at first, and is shorter and thicker. The nasal duct is three-fourths of an inch in length, and is directed downward, backward and slightly outward.

The globe is held in its place in the orbit chiefly by the four *recti* muscles (8), which, with the two *oblique*,

move it on its posterior cushion of fat, as a ball and socket joint.

(9) Junction of *cornea* with (10) *sclerotic*, which posteriorly is continuous with the fibrous covering of the optic nerve derived from the dura mater.

(11) *Iris*, which contains two muscles — the circular (*sphincter*), which surrounds the pupil, lying near the posterior surface, and is supplied by the third nerve; and the radiating muscle (*dilator*), which is chiefly supplied by the sympathetic. The iris is suspended in the fluid (*aqueous humor*) which fills the space between the cornea and the *lens*. The space in front, the anterior chamber, connects through the pupil with the posterior chamber.

(12) *Ciliary processes*, radiating folds of the *choroid* (13), sixty or seventy in number. The *ciliary muscle* (muscle of accommodation) is a ring of unstriped fibers placed at junction of iris and choroid between the ciliary processes and the sclerotic.

(14) The *retina*, the expansion of (15) the *optic nerve*.

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## THE EAR.

The organ of hearing consists of the outer cartilaginous part, the Pinna; the External Auditory Meatus; the Tympanum or Middle Ear; and the Labyrinth or Internal Ear, comprising the Vestibule, Cochlea, and Semicircular Canals. The *pinna* is composed of yellow fibro-cartilage, and has a tubular prolongation inward to form a part of the meatus.

(1) A sectional view of the bony part of the external auditory meatus. The whole canal is one inch and a quarter in length, the cartilaginous portion forming a little

less than one-third. The narrowest part of the canal is about its middle. Hence the difficulty of extracting foreign bodies which get beyond this constriction. The direction of the canal is, at first, inward, forward, and upward; then it curves slightly downward. The floor is a little longer than the roof, owing to the tympanic membrane being placed obliquely.

(2) The *membrana tympani*, a thin, semi-transparent, membranous disc, slightly oval in shape, forming a complete partition between the external auditory canal and the middle ear. It has a thin layer of true skin on its outer surface. Its inner surface is lined with the mucous membrane of the tympanum. It is supplied with sensation, in connection with the auditory canal, by a branch from the auriculo-temporal of the third division of the trifacial.

(3) Inner surface of membrana tympani, against the upper half of which lies, vertically, the handle of the *malleus* (4).

(5) The *incus* or anvil bone.

(6) The *stapes*, or stirrup bone, the base of which is attached to the membrane of the *fenestra ovalis* on the inner wall of the cavity of the tympanum. From the anterior wall of this cavity the *Eustachian tube* leads downward, forward and inward to the pharynx. On the posterior wall are three or four openings which convey air to the mastoid cells.

The internal ear consists of (7) the three semicircular canals behind; in front, (8) the cochlea; and the vestibule, a small cavity placed between (7) and (8).

(9) Termination of the auditory nerve in the cochlea.

The cochlea is in the form of a snail shell. Its base, one-fourth of an inch in diameter, corresponds to the bot-

tom of the internal auditory meatus — the apex being directed outward and forward.

The auditory nerve, the portio mollis of the seventh pair, after passing down through the internal auditory meatus, divides into two sets of branches, the anterior being distributed in the cochlea, the posterior in the vestibule.